Arlington Conservation Commission

Date: Thursday, July 16, 2020
Time: 6:30 PM
Location: Conducted by Remote Participation

Agenda

1. Administrative

   a. In accordance with the Governor's Order Suspending Certain Provisions of the Open Meeting Law, G. L. c. 30A, § 20 relating to the COVID-19 emergency, the July 16, 2020 public meeting of the Arlington Conservation Commission shall be physically closed to the public to avoid group congregation. The meeting shall instead be held virtually using Zoom.

   Topic: Conservation Commission Meeting
   Time: July 16, 2020 06:30 PM Eastern Time (US and Canada)

   Join Zoom Meeting
   https://zoom.us/j/95973689592
   Meeting ID: ***959 7368 9592***
   Password: ***333038***

   Call-in: ***+1 301 715 8592***
   +1 312 626 6799
   Meeting number: ***959 736 89592#***

   Members of the public are strongly encouraged to send written comment regarding any of the hearings listed below to Conservation Agent Emily Sullivan at esullivan@town.arlington.ma.us.

   Please read Governor Baker's Executive Order Suspending Certain Provision of Open Meeting Law for more information regarding virtual public hearings and meetings: https://www.mass.gov/doc/open-meeting-law-order-march-12- 2020/download

2. Hearings

   Notice of Intent: 869 Massachusetts Ave

   Notice of Intent: 869 Massachusetts Ave, Arlington High School
   MassDEP File #091-0323

   This Notice of Intent (NOI) was first presented to the Commission at its 05/21/2020 meeting. It is strongly encouraged that members of the public submit written comment for this NOI to the Conservation Agent in advance of the hearing, by emailing Emily Sullivan at esullivan@town.arlington.ma.us. All materials submitted for this NOI can be found on the Commission's agenda and minutes page, under the agenda for the 07/16/2020 meeting.

Hearing Summary:
The proposed project includes razing the existing high school and constructing a new high school with associated new paved parking areas, landscaping, artificial turf athletic field, bathroom building, utilities, and a new stormwater management system in accordance with the Massachusetts DEP Stormwater Standards. The existing football stadium will remain as is and is not included within the scope of this project.

Town of Arlington, Massachusetts

Notice of Intent: 869 Massachusetts Ave

Summary:
Notice of Intent: 869 Massachusetts Ave, Arlington High School
MassDEP File #091-0323

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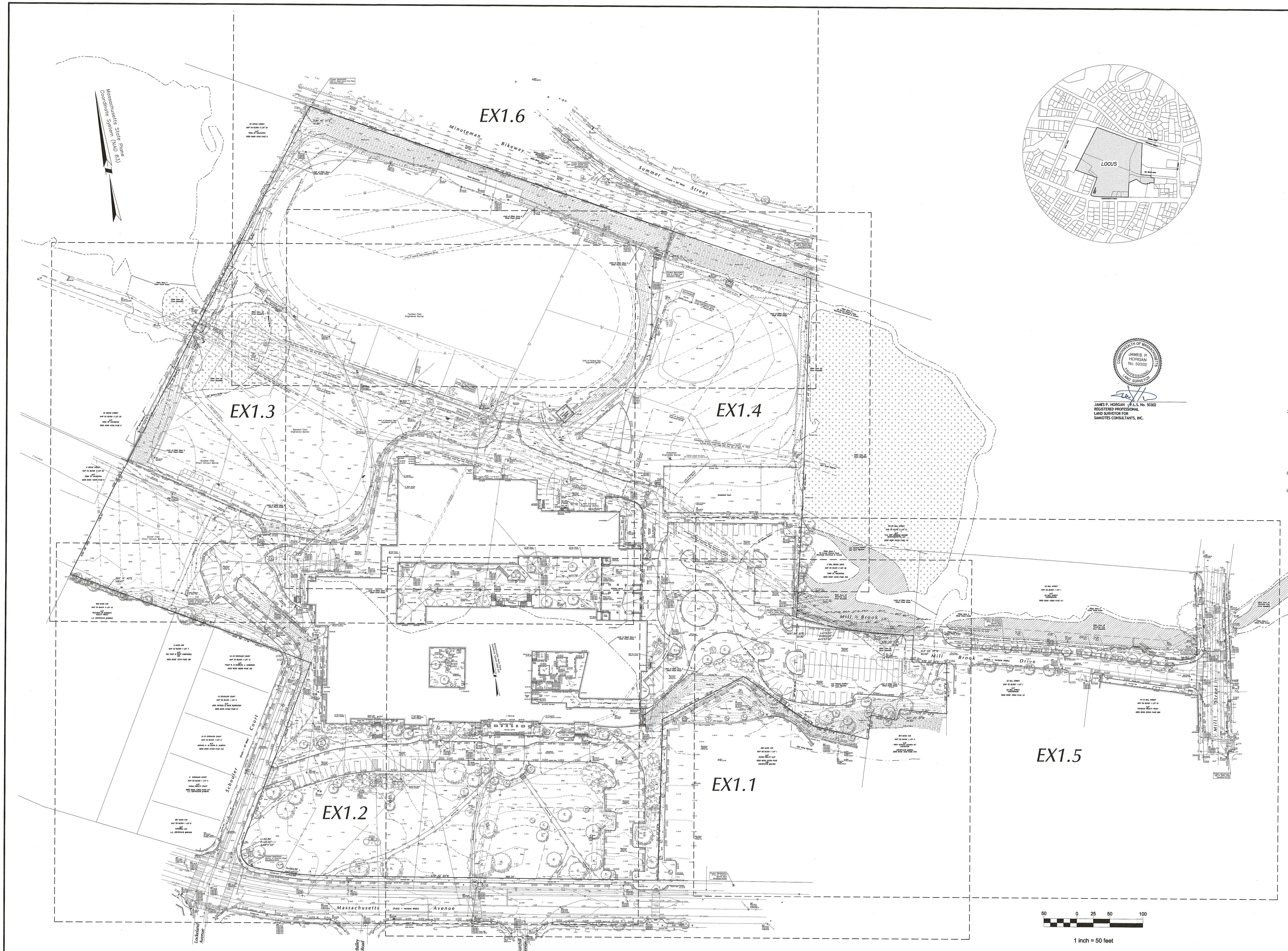
ATTACHMENTS:

Type	File Name	Description
Notice of Intent	AHS_Existing_Conditions_Plan_Set.pdf	869 Mass Ave NOI Existing Conditions Plan Set
Notice of Intent	AHS_NOI.pdf	869 Mass Ave NOI
Notice of Intent	AHS_NOI_Civil_Engineering_Plan_Set_compressed.pdf	869 Mass Ave NOI Civil Engineering Plan Set
Notice of Intent	AHS_Sports_Field_Plan_Set.pdf	869 Mass Ave NOI Sports Fields Plan Set
Notice of Intent	AHS_Stormwater_Report.pdf	869 Mass Ave NOI Stormwater Report
Notice of Intent	AHS_NOI_L3.2_Landscape_Planting_Plan.pdf	AHS NOI Landscape Plan 1
Notice of Intent	AHS_NOI_L3.1_Landscape_Planting_Plan.pdf	AHS NOI Landscape Plan 2
Notice of Intent	AHS_SWPPP_033020.pdf	AHS NOI SWPPP
Notice of Intent	AHS_Sports_Turf_NOI_Supplemental_Narrative_05-26-20.pdf	AHS NOI Turf Field Supplemental Narrative
Notice of Intent	AHS_NOI_AURA_Impervious_Calcs.pdf	AHS NOI AURA Impervious Surface Calculations
Notice of Intent	AHS_Revised_Stormwater_Report.pdf	AHS NOI Revised Stormwater Report
		AHS NOI

Notice of Intent	AHS_NOI_Environmental_Constraints_Summary.pdf	AHS NOI Environmental Constraints Narrative
Notice of Intent	AHS_NOI_Landscape_Diagrams.pdf	AHS NOI Landscape Diagrams
Notice of Intent	AHS_NOI_Rain_Garden_Narrative.pdf	AHS NOI Rain Garden Narrative
Notice of Intent	AHS_NOI_Rain_Garden_Package.pdf	AHS NOI Rain Garden Package
Notice of Intent	AHS_NOI_Riverfront_Analysis.pdf	AHS NOI Riverfront Analysis
Notice of Intent	AHS_NOI_AURA_Analysis.pdf	AHS NOI AURA Analysis
Notice of Intent	AHS_NOI_JJA_Sports_LLC_Synthetic_Turf_Potential_Health_and_Environmental_Exposure_Related_Testing.pdf	AHS NOI Artificial Turf Ecological Impact Memo
Notice of Intent	AHS_NOI_JJA_Sports_LLC_Synthetic_Turf_Use_and_Life_Cycle_Evaluation.pdf	AHS NOI Artificial Turf Life Cycle Evaluation
Notice of Intent	AHS_NOI_Artificial_Turf_Recycle_-_Reuse_-_Repurpose_2019.pdf	AHS NOI Artificial Turf Disposal Guide
Notice of Intent	AHS_NOI_Climate_Change_Summary_for_Turf_Fields_-_Ecological_Health.pdf	AHS NOI Artificial Turf Climate Change Memo
Notice of Intent	AHS_NOI_JJA_Sports_LLC_Heat_Island_Effect_of_Synthetic_Turf_06-24-20.pdf	AHS NOI Artificial Turf Heat Island Memo
Notice of Intent	AHS_NOI_Onsite_Water_Capture_for_Landscaping.pdf	AHS NOI Onsite Water Capture for Landscaping Memo
Notice of Intent	AHS_NOI_Curb_Removal___WQU_in_East_Parking_Area_Plan.pdf	AHS NOI Parking Area Curbing Revised Plan
Notice of Intent	AHS_NOI_Curb_Removal___WQU_in_East_Parking_Area.pdf	AHS NOI Parking Area Curbing Memo
Notice of Intent	AHS_NOI_Rain_Garden_bypass.pdf	AHS NOI Rain Garden Revised Plan for Bypass
Notice of Intent	AHS_NOI_Arlington_Rain_Garden_Narrative_Rev_1.pdf	AHS NOI Rain Garden Revised Memo
Notice of Intent	AHS_NOI_Stormwater_Rain_Garden_Maintenance.pdf	AHS NOI Stormwater and Rain Garden O&M Memo
Notice of Intent	AHS_NOI_Removal_of_Invasives_along_Mill_Brook.pdf	AHS NOI Mill Brook Invasive Species Removal Memo
Notice of Intent	AHS_Project_-_Site_Visit_Notes_12June2020.pdf	AHS NOI Site Visit 06122020 Notes

Notice of Intent	2020-07-02_MyRWA_Arlington_High_School_NoI_Comment_Letter.pdf	AHS NOI MyRWA Comment Letter
Notice of Intent	Letter_to_Conservation_Commission_from_AHSBC_Chair_(7.9.20).pdf	AHS Building Committee Comment Letter
Notice of Intent	Artificial_Turf_vs_Natural_Turf_Life_Cycle_Chapnick.pdf	AHS NOI S Chapnick Artificial Turf Life Cycle Analysis
Notice of Intent	Cost_Artificial_Turf._September_2016.pdf	AHS NOI TURI Artificial Turf 2016 Paper
Notice of Intent	TURI_Report_June_2019._Athletic_Playing_Fields.pdf	AHS NOI TURI Artificial Turf 2019 Report
Notice of Intent	Sharon_Artificial_Turf_Documents.pdf	AHS NOI Sharon Conservation Commission Artificial Turf Materials
Notice of Intent	Letter_to_Conservation_Commission_from_Superintendent_and_AHS_Principal.pdf	AHS NOI Superintendent and AHS Principal Comment Letter
Notice of Intent	Item_7_Climate_Change_Summary_for_Turf_Fields_-_Perf_Standards.pdf	AHS NOI Update Artificial Turf Climate Change Memo
Notice of Intent	Planting-Sketch_1.pdf	AHS NOI Western Planting Plan
Notice of Intent	Planting-Sketch_2.pdf	AHS NOI Eastern Rain Garden Planting Plan
Notice of Intent	Planting-Sketch_3.pdf	AHS NOI Eastern Planting Plan
Notice of Intent	Items_6_and_7_Filtering_of_Turf_infill_and_SMP_Standards.pdf	AHS NOI Artificial Turf Stormwater System Memo
Notice of Intent	Item_2_Western_Field_AURA_analysis.pdf	AHS NOI Western AURA Analysis
Notice of Intent	Item_5_Area_drain_figure.pdf	AHS NOI Western Drain
Notice of Intent	AHS_NOI_Public_Comment_07102020_Trevor_Smith.PNG	Public Comment Trevor Smith
Notice of Intent	AHS_NOI_Public_Comment_07132020_Kristina_Perry.PNG	Public Comment Kristina Perry
Notice of Intent	AHS_NOI_Public_Comment_07132020_Elizabeth_Rocco.PNG	Public Comment Elizabeth Rocco
Notice		Public

Notice of Intent	AHS_NOI_Public_Comment_07132020_Madeline_Brambilla.PNG	Comment Madeline Brambilla
Notice of Intent	AHS_NOI_Public_Comment_07132020_Wyatt_LaCoss.PNG	Public Comment Wyatt LaCoss
Notice of Intent	AHS_NOI_Public_Comment_07132020_Jessi_Smolow.PNG	Public Comment Jessi Smolow
Notice of Intent	AHS_NOI_Public_Comment_07132020_James_Fleming.PNG	Public Comment James Fleming
Notice of Intent	AHS_NOI_Public_Comment_07142020_Joshua_Shalem.PNG	Public Comment Joshua Shalem
Notice of Intent	AHS_NOI_Public_Comment_07142020_Tina_Halfpenny.PNG	Public Comment Tina Halfpenny



NOTES:

1. THIS PLAN IS REFERENCED HORIZONTALLY TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM NORTH AMERICAN DATUM OF 1983 AND VERTICALLY TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 BY RTK GPS OBSERVATIONS TAKEN ON MAY 4, 2018. SEE PLAN FOR PROJECT BENCHMARK LOCATIONS.
2. THIS PLAN IS THE RESULT OF AN INSTRUMENT SURVEY PERFORMED IN MAY, JUNE & JULY OF 2018 AND JULY, AUGUST, SEPTEMBER & OCTOBER OF 2019.
3. UNDERGROUND UTILITIES ARE BASED UPON AN ACTUAL FIELD SURVEY AND INFORMATION OF RECORD. IT IS NOT WARRANTED THAT THEY ARE EXACTLY LOCATED, NOR THAT ALL UNDERGROUND CONDUITS OR OTHER STRUCTURES ARE SHOWN ON THIS PLAN. *CONTACT DIGSAFE 811 PRIOR TO ANY EXCAVATION.
4. ABUTTERS' NAMES REFER TO CURRENT TOWN OF ARLINGTON ASSESSOR'S RECORDS.
5. THE SUBJECT LAND AS SHOWN LIES PARTIALLY WITHIN ZONE X AREAS DETERMINED TO BE OUTSIDE THE 0.2% ANNUAL CHANCE FLOODPLAIN, ZONE X OTHER FLOOD AREAS, ZONE AE BASE FLOOD ELEVATIONS DETERMINED, AND FLOODWAY AREAS IN ZONE AE, AS INDICATED ON MAP NUMBER 25017C0416E FOR THE TOWN OF ARLINGTON, COMMUNITY NO. 250177, HAVING AN EFFECTIVE DATE OF JUNE 4, 2010. THE FEMA ZONES DEPICTED ON THIS PLAN WERE OBTAINED FROM THE MASSACHUSETTS GIS DATABASE.
6. PROPERTY LINES SHOWN HEREON WERE DETERMINED FROM THE FOLLOWING PLANS OF RECORD FILED AT THE MIDDLESEX SOUTH COUNTY REGISTRY OF DEEDS, THE MASSACHUSETTS LAND COURT AND THE TOWN OF ARLINGTON PUBLIC WORKS DEPARTMENT ENGINEERING DIVISION.

   - Plan Book 130 Plan 41
   - Plan Book 207 Plan 8
   - Plan Book 223 Plan 41
   - Filed Plan No. 833
   - Plan No. 564 of 1929
   - Plan No. 814 of 1929
   - Plan No. 1617 of 1947
   - Plan No. 924 of 1955
   - Plan No. 963 of 1959
   - Plan No. 1629 of 1960
   - Plan No. 1589 of 1962
   - Plan No. 580 of 1954
   - Plan No. 281 of 1967
   - Plan No. 963 of 1969
   - Plan No. 1103 of 1974
   - Plan No. 1142 of 1974
   - Plan No. 144 of 1975
   - Plan No. 1055 of 1975
   - Plan No. 1056 of 1975
   - Plan No. 3 of 1976
   - Plan No. 556 of 1976
   - Plan No. 470 of 1984
   - Plan No. 766 of 2001
   - Plan No. 851 of 2006

   - Land Court Case No. 26054

   - 1893 County Layout Massachusetts Avenue
   - 1960 County Relocation Massachusetts Avenue
   - 1961 County Relocation Massachusetts Avenue
   - 1962 County Relocation Massachusetts Avenue
   - 1918 County Layout Summer Street
   - 1964 County Relocation Summer Street
   - 1964 County Layout Grove Street

   - 1916 Town Layout Schouler Court
   - 1952 Town Layout Mill Brook Drive

   - Plan No. 9139 filed at the Town of Arlington Department of Public Works Engineering Division.

   - Plan of Land by Schofield Brothers, Inc. entitled "Topographical Plan of Land in Arlington, Mass." dated April 24, 1974 and filed at the Town of Arlington Department of Public Works Engineering Division.

   - Plan of Land by R.J. O'Connell & Associates, Inc. entitled "CVS/pharmacy, Arlington, MA, ALTA/ACSM Land Title Survey" dated May 21, 2008 and filed at the Town of Arlington Department of Public Works Engineering Division.

7. THE CURRENT RECORD OWNER IS THE TOWN OF ARLINGTON. SEE THE FOLLOWING DOCUMENTS RECORDED AT THE MIDDLESEX SOUTH COUNTY REGISTRY OF DEEDS.

   - Deed Book 3886 Pages 285–292
   - Deed Book 5371 Page 352
   - Deed Book 5380 Page 108
   - Deed Book 5399 Page 283
   - Deed Book 5408 Page 483
   - Deed Book 5450 Page 411
   - Deed Book 8136 Page 360
   - Deed Book 12709 Page 513
   - Deed Book 12917 Page 529

8. THIS SURVEY WAS PERFORMED WITHOUT THE BENEFIT OF A TITLE SEARCH AND MAY NOT SHOW OR REVEAL ANY FACTS THAT WOULD BE DISCLOSED BY ONE.
9. THE SURVEYOR RECEIVED A LETTER FROM THE DEPARTMENT OF CONSERVATION AND RECREATION (DCR) STATING THAT RESPONSIBILITY FOR METROPOLITAN DISTRICT COMMISSION (MDC) WATER AND SEWER LINES WAS TRANSFERRED TO THE MASSACHUSETTS WATER RESOURCES AUTHORITY (MWRA) IN THE MID–1980'S.

COMMONWEALTH OF MASSACHUSETTS
JAMES P. HORGAN
No. 50302
PROFESSIONAL LAND SURVEYOR

JAMES P. HORGAN ~ P.L.S. No. 50302
REGISTERED PROFESSIONAL
LAND SURVEYOR FOR
SAMIOTES CONSULTANTS, INC.

LEGEND

	CATCHBASIN
	DRAIN MANHOLE
	AREA DRAIN
	ROOF DRAIN
RL	ROOF LEADER
	SEWER MANHOLE
CO	CLEAN OUT
	VENT
	WATER MANHOLE
	HYDRANT
	WATER GATE
	WATER SERVICE
BWW	BWSC WATER GATE
	WELL
	MONITORING WELL
ICV	IRRIGATION CONTROL VALVE
PIV	POST INDICATOR VALVE
	GAS MANHOLE
GM	GAS METER
	GAS GATE
	GAS SERVICE
	ELECTRIC MANHOLE
EM	ELECTRIC METER
	ELECTRIC BOX
	UTILITY POLE
	LIGHT POLE
	HANDHOLE
TRANS	TRANSFORMER
	COMMUNICATIONS MANHOLE
	CATV BOX
	TELEPHONE MANHOLE
	TELEPHONE BOX
	FIRE COMMUNICATIONS MANHOLE
	FIRE CALL BOX
	FIRE SPRINKLER CONNECTION
	STEAM MANHOLE
	UNKNOWN MANHOLE
	SIGN
	BOLLARD
	MAILBOX
	POST
	PARKING METER
	GUY WIRE
	WETLAND FLAG
	BORING
	TEST PIT
	CONCRETE BOUND
	CONCRETE BOUND DRILL HOLE
	STONE BOUND
	STONE BOUND DRILL HOLE
	IRON PIPE
	DRILLHOLE
	IRON REBAR
	DECIDUOUS TREE
	CONIFEROUS TREE
	SHRUB
	STUMP
	FLAGPOLE
	HANDICAP PARKING SPACE
	TRAFFIC CONTROL BOX
	TRAFFIC SIGNAL
—D—	DRAIN LINE
—S—	SEWER LINE
—W—	WATER LINE
—W(IR)—	IRRIGATION WATER LINE
—G—	GAS LINE
—E—	ELECTRIC LINE
—C—	COMMUNICATIONS LINE
—T—	TELEPHONE LINE
—F—	FIRE COMMUNICATIONS LINE
—ST—	STEAM LINE
—OHW—	OVERHEAD WIRE
----60----	INDEX CONTOUR
----59----	INTERMEDIATE CONTOUR
+58.7	SPOT GRADE
tc=	TOP OF CURB ELEVATION
bc=	BOTTOM OF CURB ELEVATION
tw=	TOP OF WALL ELEVATION
bw=	BOTTOM OF WALL ELEVATION
ts=	TOP OF STEPS ELEVATION
bs=	BOTTOM OF STEPS ELEVATION AT GRADE
ds=	DOOR SILL ELEVATION
ffe=	FINISHED FLOOR ELEVATION
WW	WINDOW WELL
DWS	DETECTABLE WARNING STRIP
n/a	INVERT NOT AVAILABLE
EOP	EDGE OF PAVEMENT
EOG	EDGE OF GRAVEL
EOS	EDGE OF STONE
EOC	EDGE OF CONCRETE
OH	OVERHANG
HR	HAND RAIL
(R)	RECORD INFORMATION

HMFH

HMFH ARCHITECTS

130 Bishop Allen Drive
Cambridge, MA 02139
617 492 2200
@HMFHarch hmfh.com

samiotes

Samiotes Consultants Inc.
Civil Engineers + Land Surveyors

20 A Street
Framingham, MA 01701

T 508.877.6688
F 508.877.8349
www.samiotes.com

SITE ENABLING
ADDENDA INCORPORATED SET 4.23.20

Arlington High School
Massachusetts Avenue, Arlington, Massachusetts

EXISTING CONDITIONS PLAN

SCALE: AS SHOWN DRAWN BY: JPH / FA CHECKED BY: JPH / TMC

DRAWING NUMBER
KEY

JOB NUMBER 17211

HMFH
HMFH ARCHITECTS
130 Bishop Allen Drive
Cambridge, MA 02139
617 492 2200
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SITE ENABLING
ADDENDA INCORPORATED SET 4.23.20

Arlington High School
Massachusetts Avenue, Arlington, Massachusetts
EXISTING CONDITIONS PLAN
SCALE: AS SHOWN DRAWN BY: JPH / FA CHECKED BY: JPH / TMC

DRAWING NUMBER
EX1.1
JOB NUMBER 17211

HMFH

HMFH ARCHITECTS
130 Bishop Allen Drive
Cambridge, MA 02139
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SITE ENABLING
ADDENDA INCORPORATED SET 4.23.20

Arlington High School
Massachusetts Avenue, Arlington, Massachusetts
EXISTING CONDITIONS PLAN

SCALE: AS SHOWN DRAWN BY: JPH / FA CHECKED BY: JPH / TMC

DRAWING NUMBER
EX1.2

JOB NUMBER 17211

HMFH

HMFH ARCHITECTS
130 Bishop Allen Drive
Cambridge, MA 02139
617 492 2200
@HMFHarch hmfh.com

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SITE ENABLING
ADDENDA INCORPORATED SET 4.23.20

Arlington High School
Massachusetts Avenue, Arlington, Massachusetts
EXISTING CONDITIONS PLAN

SCALE: AS SHOWN DRAWN BY: JPH / FA CHECKED BY: JPH / TMC

DRAWING NUMBER
EX1.3

JOB NUMBER 17211

HMFH

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130 Bishop Allen Drive
Cambridge, MA 02139
617 492 2200
@HMFHarch hmfh.com

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Civil Engineers + Land Surveyors
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Framingham, MA 01701
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F 508.877.8349
www.samiotes.com

SITE ENABLING
ADDENDA INCORPORATED SET 4.23.20

Arlington High School
Massachusetts Avenue, Arlington, Massachusetts
EXISTING CONDITIONS PLAN

SCALE: AS SHOWN DRAWN BY: JPH / FA CHECKED BY: JPH / TMC

DRAWING NUMBER
EX1.4

JOB NUMBER 17211

H M
F H

HMFH ARCHITECTS
130 Bishop Allen Drive
Cambridge, MA 02139
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F 508.877.8349
www.samiotes.com

SITE ENABLING
ADDENDA INCORPORATED SET 4.23.20

Arlington High School
Massachusetts Avenue, Arlington, Massachusetts
EXISTING CONDITIONS PLAN

SCALE: AS SHOWN DRAWN BY: JPH / FA CHECKED BY: JPH / TMC

DRAWING NUMBER
EX1.5

JOB NUMBER 17211

JAMES P. HORGAN – P.L.S. No. 50302
REGISTERED PROFESSIONAL
LAND SURVEYOR FOR
SAMIOTES CONSULTANTS, INC.

HMFH

HMFH ARCHITECTS
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F 508.877.8349
www.samiotes.com

SITE ENABLING
ADDENDA INCORPORATED SET 4.23.20

Arlington High School
Massachusetts Avenue, Arlington, Massachusetts
EXISTING CONDITIONS PLAN

SCALE: AS SHOWN DRAWN BY: JPH / FA CHECKED BY: JPH / TMC

DRAWING NUMBER
EX1.6

JOB NUMBER 17211

ARLINGTON HIGH SCHOOL
869 MASSACHUSETTS AVENUE
ARLINGTON, MA 02476

NOTICE OF INTENT

Pursuant to M.G.L c. 131 §40
& Arlington Bylaws Article

Submitted to:
Town of Arlington Conservation Commission &
Massachusetts Department of Environmental Protection

Applicant:
Adanm Chapdelain
Town of Arlington
730 Mass. Ave. Annex
Arlington, MA 02476

Architect:
HMFH Architects
130 Bishop Allen Drive
Boston, MA 02139

Civil Engineer:
Samiotes Consultants, Inc.
20 A Street
Framingham, MA 01701

samiotes

07 May 2020

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands

WPA Form 3 – Notice of Intent

Massachusetts Wetlands Protection Act M.G.L. c. 131, §40

Provided by MassDEP:

MassDEP File Number

Document Transaction Number

Arlington
City/Town

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.

Note: Before completing this form consult your local Conservation Commission regarding any municipal bylaw or ordinance.

A. General Information

1. Project Location (**Note:** electronic filers will click on button to locate project site):

869 Massachusetts Ave	Arlington	02476
a. Street Address	b. City/Town	c. Zip Code

Latitude and Longitude:

42.418739	-71.161348
d. Latitude	e. Longitude

53-2-4	
f. Assessors Map/Plat Number	g. Parcel /Lot Number

2. Applicant:

Adam	Chapdelaine
a. First Name	b. Last Name

Town of Arlington
c. Organization

730 Mass. Ave. Annex
d. Street Address

Arlington	MA	02476
e. City/Town	f. State	g. Zip Code
781 316-3010	716 316-3019	achapdelaine@town.arlington.ma.us
h. Phone Number	i. Fax Number	j. Email Address

3. Property owner (required if different from applicant): ☐ Check if more than one owner

a. First Name	b. Last Name

c. Organization

d. Street Address

e. City/Town	f. State	g. Zip Code
h. Phone Number	i. Fax Number	j. Email address

4. Representative (if any):

Stephen	Garvin, PE
a. First Name	b. Last Name

Samiotes Consultants
c. Company

20 A Street
d. Street Address

Framingham	MA	01701
e. City/Town	f. State	g. Zip Code
508 877-6688 x 13	508 877-8349	sgarvin@samiotes.com
h. Phone Number	i. Fax Number	j. Email address

5. Total WPA Fee Paid (from NOI Wetland Fee Transmittal Form):

$0	$0	$0
a. Total Fee Paid	b. State Fee Paid	c. City/Town Fee Paid

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands

WPA Form 3 – Notice of Intent

Massachusetts Wetlands Protection Act M.G.L. c. 131, §40

Provided by MassDEP:

MassDEP File Number

Document Transaction Number

Arlington
City/Town

A. General Information (continued)

6. General Project Description:

See attached narrative.

7a. Project Type Checklist: (Limited Project Types see Section A. 7b.)

1. ☐ Single Family Home
2. ☐ Residential Subdivision
3. ☐ Commercial/Industrial
4. ☐ Dock/Pier
5. ☐ Utilities
6. ☐ Coastal engineering Structure
7. ☐ Agriculture (e.g., cranberries, forestry)
8. ☐ Transportation
9. ☒ Other

7b. Is any portion of the proposed activity eligible to be treated as a limited project (including Ecological Restoration Limited Project) subject to 310 CMR 10.24 (coastal) or 310 CMR 10.53 (inland)?

1. ☐ Yes ☒ No If yes, describe which limited project applies to this project. (See 310 CMR 10.24 and 10.53 for a complete list and description of limited project types)

2. Limited Project Type

If the proposed activity is eligible to be treated as an Ecological Restoration Limited Project (310 CMR10.24(8), 310 CMR 10.53(4)), complete and attach Appendix A: Ecological Restoration Limited Project Checklist and Signed Certification.

8. Property recorded at the Registry of Deeds for:

South Middlesex
a. County

b. Certificate # (if registered land)

3886, 5371, 5380, 5399, 5408, 5450, 8136, 12709, 12917

285-292, 352, 108, 283, 483, 411, 360, 513, 529
d. Page Number

B. Buffer Zone & Resource Area Impacts (temporary & permanent)

1. ☒ Buffer Zone Only – Check if the project is located only in the Buffer Zone of a Bordering Vegetated Wetland, Inland Bank, or Coastal Resource Area.
2. ☒ Inland Resource Areas (see 310 CMR 10.54-10.58; if not applicable, go to Section B.3, Coastal Resource Areas).

Check all that apply below. Attach narrative and any supporting documentation describing how the project will meet all performance standards for each of the resource areas altered, including standards requiring consideration of alternative project design or location.

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands
WPA Form 3 – Notice of Intent
Massachusetts Wetlands Protection Act M.G.L. c. 131, §40

Provided by MassDEP:

MassDEP File Number

Document Transaction Number

Arlington
City/Town

B. Buffer Zone & Resource Area Impacts (temporary & permanent) (cont'd)

For all projects affecting other Resource Areas, please attach a narrative explaining how the resource area was delineated.

Resource Area	Size of Proposed Alteration	Proposed Replacement (if any)
a. ☐ Bank	1. linear feet	2. linear feet
b. ☐ Bordering Vegetated Wetland	1. square feet	2. square feet
c. ☐ Land Under Waterbodies and Waterways	1. square feet 3. cubic yards dredged	2. square feet

Resource Area	Size of Proposed Alteration	Proposed Replacement (if any)
d. ☐ Bordering Land Subject to Flooding	1. square feet 3. cubic feet of flood storage lost	2. square feet 4. cubic feet replaced
e. ☐ Isolated Land Subject to Flooding	1. square feet 2. cubic feet of flood storage lost	3. cubic feet replaced

f. ☒ Riverfront Area — Mill Brook
1. Name of Waterway (if available) - **specify coastal or inland**

2. Width of Riverfront Area (check one):

☐ 25 ft. - Designated Densely Developed Areas only

☐ 100 ft. - New agricultural projects only

☒ 200 ft. - All other projects

3. Total area of Riverfront Area on the site of the proposed project: 34,667 sf (20,275 sf previously degraded)

4. Proposed alteration of the Riverfront Area:

Total = 4,937	100'= 18,863 sf (17,093 sf previously degraded)	100'-200'=6,221 sf (3,053 sf previously degraded)
a. total square feet		

5. Has an alternatives analysis been done and is it attached to this NOI? ☒ Yes ☐ No

6. Was the lot where the activity is proposed created prior to August 1, 1996? ☒ Yes ☐ No

3. ☐ Coastal Resource Areas: (See 310 CMR 10.25-10.35)

Note: for coastal riverfront areas, please complete **Section B.2.f**. above.

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands
WPA Form 3 – Notice of Intent
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Provided by MassDEP:

MassDEP File Number

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City/Town

B. Buffer Zone & Resource Area Impacts (temporary & permanent) (cont'd)

Check all that apply below. Attach narrative and supporting documentation describing how the project will meet all performance standards for each of the resource areas altered, including standards requiring consideration of alternative project design or location.

Online Users: Include your document transaction number (provided on your receipt page) with all supplementary information you submit to the Department.

Resource Area	Size of Proposed Alteration	Proposed Replacement (if any)
a. ☐ Designated Port Areas	Indicate size under Land Under the Ocean, below	
b. ☐ Land Under the Ocean	1. square feet 2. cubic yards dredged	
c. ☐ Barrier Beach	Indicate size under Coastal Beaches and/or Coastal Dunes below	
d. ☐ Coastal Beaches	1. square feet	2. cubic yards beach nourishment
e. ☐ Coastal Dunes	1. square feet	2. cubic yards dune nourishment

	Size of Proposed Alteration	Proposed Replacement (if any)
f. ☐ Coastal Banks	1. linear feet	
g. ☐ Rocky Intertidal Shores	1. square feet	
h. ☐ Salt Marshes	1. square feet	2. sq ft restoration, rehab., creation
i. ☐ Land Under Salt Ponds	1. square feet 2. cubic yards dredged	
j. ☐ Land Containing Shellfish	1. square feet	
k. ☐ Fish Runs	Indicate size under Coastal Banks, inland Bank, Land Under the Ocean, and/or inland Land Under Waterbodies and Waterways, above 1. cubic yards dredged	
l. ☐ Land Subject to Coastal Storm Flowage	1. square feet	

4. ☐ Restoration/Enhancement
If the project is for the purpose of restoring or enhancing a wetland resource area in addition to the square footage that has been entered in Section B.2.b or B.3.h above, please enter the additional amount here.

a. square feet of BVW

b. square feet of Salt Marsh

5. ☐ Project Involves Stream Crossings

a. number of new stream crossings

b. number of replacement stream crossings

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Provided by MassDEP:

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C. Other Applicable Standards and Requirements

☐ This is a proposal for an Ecological Restoration Limited Project. Skip Section C and complete Appendix A: Ecological Restoration Limited Project Checklists – Required Actions (310 CMR 10.11).

Streamlined Massachusetts Endangered Species Act/Wetlands Protection Act Review

1. Is any portion of the proposed project located in **Estimated Habitat of Rare Wildlife** as indicated on the most recent Estimated Habitat Map of State-Listed Rare Wetland Wildlife published by the Natural Heritage and Endangered Species Program (NHESP)? To view habitat maps, see the *Massachusetts Natural Heritage Atlas* or go to http://maps.massgis.state.ma.us/PRI_EST_HAB/viewer.htm.

a. ☐ Yes ☒ No

If yes, include proof of mailing or hand delivery of NOI to:

Natural Heritage and Endangered Species Program
Division of Fisheries and Wildlife
1 Rabbit Hill Road
Westborough, MA 01581

b. Date of map

If *yes*, the project is also subject to Massachusetts Endangered Species Act (MESA) review (321 CMR 10.18). To qualify for a streamlined, 30-day, MESA/Wetlands Protection Act review, please complete Section C.1.c, and include requested materials with this Notice of Intent (NOI); *OR* complete Section C.2.f, if applicable. *If MESA supplemental information is not included with the NOI, by completing Section 1 of this form, the NHESP will require a separate MESA filing which may take up to 90 days to review (unless noted exceptions in Section 2 apply, see below).*

c. Submit Supplemental Information for Endangered Species Review*

1. ☐ Percentage/acreage of property to be altered:

(a) within wetland Resource Area ________ percentage/acreage

(b) outside Resource Area ________ percentage/acreage

2. ☐ Assessor's Map or right-of-way plan of site

2. ☒ Project plans for entire project site, including wetland resource areas and areas outside of wetlands jurisdiction, showing existing and proposed conditions, existing and proposed tree/vegetation clearing line, and clearly demarcated limits of work **

(a) ☒ Project description (including description of impacts outside of wetland resource area & buffer zone)

(b) ☐ Photographs representative of the site

* Some projects **not** in Estimated Habitat may be located in Priority Habitat, and require NHESP review (see http://www.mass.gov/eea/agencies/dfg/dfw/natural-heritage/regulatory-review/). Priority Habitat includes habitat for state-listed plants and strictly upland species not protected by the Wetlands Protection Act.

** MESA projects may not be segmented (321 CMR 10.16). The applicant must disclose full development plans even if such plans are not required as part of the Notice of Intent process.

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C. Other Applicable Standards and Requirements (cont'd)

(c) ☐ MESA filing fee (fee information available at http://www.mass.gov/dfwele/dfw/nhesp/regulatory_review/mesa/mesa_fee_schedule.htm). Make check payable to "Commonwealth of Massachusetts - NHESP" and ***mail to NHESP*** at above address

*Projects altering **10 or more acres** of land, also submit:*

(d) ☐ Vegetation cover type map of site

(e) ☐ Project plans showing Priority & Estimated Habitat boundaries

(f) OR Check One of the Following

1. ☐ Project is exempt from MESA review.
Attach applicant letter indicating which MESA exemption applies. (See 321 CMR 10.14, http://www.mass.gov/dfwele/dfw/nhesp/regulatory_review/mesa/mesa_exemptions.htm; the NOI must still be sent to NHESP if the project is within estimated habitat pursuant to 310 CMR 10.37 and 10.59.)

2. ☐ Separate MESA review ongoing. ______ a. NHESP Tracking # ______ b. Date submitted to NHESP

3. ☐ Separate MESA review completed.
Include copy of NHESP "no Take" determination or valid Conservation & Management Permit with approved plan.

3. For coastal projects only, is any portion of the proposed project located below the mean high water line or in a fish run?

a. ☒ Not applicable – project is in inland resource area only b. ☐ Yes ☐ No

If yes, include proof of mailing, hand delivery, or electronic delivery of NOI to either:

South Shore - Cohasset to Rhode Island border, and the Cape & Islands:

Division of Marine Fisheries -
Southeast Marine Fisheries Station
Attn: Environmental Reviewer
836 South Rodney French Blvd.
New Bedford, MA 02744
Email: DMF.EnvReview-South@state.ma.us

North Shore - Hull to New Hampshire border:

Division of Marine Fisheries -
North Shore Office
Attn: Environmental Reviewer
30 Emerson Avenue
Gloucester, MA 01930
Email: DMF.EnvReview-North@state.ma.us

Also if yes, the project may require a Chapter 91 license. For coastal towns in the Northeast Region, please contact MassDEP's Boston Office. For coastal towns in the Southeast Region, please contact MassDEP's Southeast Regional Office.

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands
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Provided by MassDEP:

MassDEP File Number

Document Transaction Number

Arlington
City/Town

C. Other Applicable Standards and Requirements (cont'd)

Online Users: Include your document transaction number (provided on your receipt page) with all supplementary information you submit to the Department.

4. Is any portion of the proposed project within an Area of Critical Environmental Concern (ACEC)?

   a. ☐ Yes ☒ No If yes, provide name of ACEC (see instructions to WPA Form 3 or MassDEP Website for ACEC locations). **Note:** electronic filers click on Website.

   b. ACEC

5. Is any portion of the proposed project within an area designated as an Outstanding Resource Water (ORW) as designated in the Massachusetts Surface Water Quality Standards, 314 CMR 4.00?

   a. ☐ Yes ☒ No

6. Is any portion of the site subject to a Wetlands Restriction Order under the Inland Wetlands Restriction Act (M.G.L. c. 131, § 40A) or the Coastal Wetlands Restriction Act (M.G.L. c. 130, § 105)?

   a. ☐ Yes ☒ No

7. Is this project subject to provisions of the MassDEP Stormwater Management Standards?

   a. ☒ Yes. Attach a copy of the Stormwater Report as required by the Stormwater Management Standards per 310 CMR 10.05(6)(k)-(q) and check if:

      1. ☐ Applying for Low Impact Development (LID) site design credits (as described in Stormwater Management Handbook Vol. 2, Chapter 3)

      2. ☐ A portion of the site constitutes redevelopment

      3. ☒ Proprietary BMPs are included in the Stormwater Management System.

   b. ☐ No. Check why the project is exempt:

      1. ☐ Single-family house

      2. ☐ Emergency road repair

      3. ☐ Small Residential Subdivision (less than or equal to 4 single-family houses or less than or equal to 4 units in multi-family housing project) with no discharge to Critical Areas.

D. Additional Information

☐ This is a proposal for an Ecological Restoration Limited Project. Skip Section D and complete Appendix A: Ecological Restoration Notice of Intent – Minimum Required Documents (310 CMR 10.12).

Applicants must include the following with this Notice of Intent (NOI). See instructions for details.

Online Users: Attach the document transaction number (provided on your receipt page) for any of the following information you submit to the Department.

1. ☒ USGS or other map of the area (along with a narrative description, if necessary) containing sufficient information for the Conservation Commission and the Department to locate the site. (Electronic filers may omit this item.)

2. ☒ Plans identifying the location of proposed activities (including activities proposed to serve as a Bordering Vegetated Wetland [BVW] replication area or other mitigating measure) relative to the boundaries of each affected resource area.

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D. Additional Information (cont'd)

3. ☐ Identify the method for BVW and other resource area boundary delineations (MassDEP BVW Field Data Form(s), Determination of Applicability, Order of Resource Area Delineation, etc.), and attach documentation of the methodology.

4. ☐ List the titles and dates for all plans and other materials submitted with this NOI.

See attached Drawing List
a. Plan Title

Samiotes Consultants, Inc
b. Prepared By

Stephen Garvin, PE
c. Signed and Stamped by

d. Final Revision Date

Varies
e. Scale

f. Additional Plan or Document Title

g. Date

5. ☐ If there is more than one property owner, please attach a list of these property owners not listed on this form.

6. ☐ Attach proof of mailing for Natural Heritage and Endangered Species Program, if needed.

7. ☐ Attach proof of mailing for Massachusetts Division of Marine Fisheries, if needed.

8. ☒ Attach NOI Wetland Fee Transmittal Form

9. ☒ Attach Stormwater Report, if needed.

E. Fees

1. ☒ Fee Exempt: No filing fee shall be assessed for projects of any city, town, county, or district of the Commonwealth, federally recognized Indian tribe housing authority, municipal housing authority, or the Massachusetts Bay Transportation Authority.

Applicants must submit the following information (in addition to pages 1 and 2 of the NOI Wetland Fee Transmittal Form) to confirm fee payment:

Fee Exempt
2. Municipal Check Number

Fee Exempt
3. Check date

Fee Exempt
4. State Check Number

Fee Exempt
5. Check date

Fee Exempt
6. Payor name on check: First Name

Fee Exempt
7. Payor name on check: Last Name

Massachusetts Department of Environmental Protection
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Massachusetts Wetlands Protection Act M.G.L. c. 131, §40

Provided by MassDEP:

MassDEP File Number

Document Transaction Number

City/Town

F. Signatures and Submittal Requirements

I hereby certify under the penalties of perjury that the foregoing Notice of Intent and accompanying plans, documents, and supporting data are true and complete to the best of my knowledge. I understand that the Conservation Commission will place notification of this Notice in a local newspaper at the expense of the applicant in accordance with the wetlands regulations, 310 CMR 10.05(5)(a).

I further certify under penalties of perjury that all abutters were notified of this application, pursuant to the requirements of M.G.L. c. 131, § 40. Notice must be made by Certificate of Mailing or in writing by hand delivery or certified mail (return receipt requested) to all abutters within 100 feet of the property line of the project location.

[signature]	May 4, 2020
1. Signature of Applicant	2. Date
3. Signature of Property Owner (if different)	4. Date
5. Signature of Representative (if any)	6. Date

For Conservation Commission:
Two copies of the completed Notice of Intent (Form 3), including supporting plans and documents, two copies of the NOI Wetland Fee Transmittal Form, and the city/town fee payment, to the Conservation Commission by certified mail or hand delivery.

For MassDEP:
One copy of the completed Notice of Intent (Form 3), including supporting plans and documents, one copy of the NOI Wetland Fee Transmittal Form, and a **copy** of the state fee payment to the MassDEP Regional Office (see Instructions) by certified mail or hand delivery.

Other:
If the applicant has checked the “yes” box in any part of Section C, Item 3, above, refer to that section and the Instructions for additional submittal requirements.

The original and copies must be sent simultaneously. Failure by the applicant to send copies in a timely manner may result in dismissal of the Notice of Intent.

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands

NOI Wetland Fee Transmittal Form

Massachusetts Wetlands Protection Act M.G.L. c. 131, §40

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.

A. Applicant Information

1. Location of Project:

869 Massachusetts Ave	Arlington
a. Street Address	b. City/Town
Exempt	Exempt
c. Check number	d. Fee amount

2. Applicant Mailing Address:

Adam		Chapdelaine	
a. First Name		b. Last Name	
Town of Arlington			
c. Organization			
730 Massachusetts Ave. Annex			
d. Mailing Address			
Arlington		MA	02476
e. City/Town		f. State	g. Zip Code
781 316-3010	781 316-3019	achapdelaine@town.arlington.ma.us	
h. Phone Number	i. Fax Number	j. Email Address	

3. Property Owner (if different):

a. First Name		b. Last Name	
c. Organization			
d. Mailing Address			
e. City/Town		f. State	g. Zip Code
h. Phone Number	i. Fax Number	j. Email Address	

To calculate filing fees, refer to the category fee list and examples in the instructions for filling out WPA Form 3 (Notice of Intent).

B. Fees

Fee should be calculated using the following process & worksheet. ***Please see Instructions before filling out worksheet.***

Step 1/Type of Activity: Describe each type of activity that will occur in wetland resource area and buffer zone.

Step 2/Number of Activities: Identify the number of each type of activity.

Step 3/Individual Activity Fee: Identify each activity fee from the six project categories listed in the instructions.

Step 4/Subtotal Activity Fee: Multiply the number of activities (identified in Step 2) times the fee per category (identified in Step 3) to reach a subtotal fee amount. Note: If any of these activities are in a Riverfront Area in addition to another Resource Area or the Buffer Zone, the fee per activity should be multiplied by 1.5 and then added to the subtotal amount.

Step 5/Total Project Fee: Determine the total project fee by adding the subtotal amounts from Step 4.

Step 6/Fee Payments: To calculate the state share of the fee, divide the total fee in half and subtract $12.50. To calculate the city/town share of the fee, divide the total fee in half and add $12.50.

B. Fees (continued)

Step 1/Type of Activity	Step 2/Number of Activities	Step 3/Individual Activity Fee	Step 4/Subtotal Activity Fee
MSBA Funded H.S.			

Step 5/Total Project Fee: ______________

Step 6/Fee Payments:

Total Project Fee: $0
a. Total Fee from Step 5

State share of filing Fee: $0
b. 1/2 Total Fee **less $**12.50

City/Town share of filling Fee: $0
c. 1/2 Total Fee **plus** $12.50

C. Submittal Requirements

a.) Complete pages 1 and 2 and send with a check or money order for the state share of the fee, payable to the Commonwealth of Massachusetts.

Department of Environmental Protection
Box 4062
Boston, MA 02211

b.) **To the Conservation Commission:** Send the Notice of Intent or Abbreviated Notice of Intent; a **copy** of this form; and the city/town fee payment.

To MassDEP Regional Office (see Instructions): Send a copy of the Notice of Intent or Abbreviated Notice of Intent; a **copy** of this form; and a **copy** of the state fee payment. (E-filers of Notices of Intent may submit these electronically.)

ARLINGTON HIGH SCHOOL
PROJECT NARRATIVE
ARLINGTON, MA

1.0 Introduction

The existing site, located at 869 Massachusetts Avenue, Arlington, MA, consists of the Arlington High School campus, containing the existing Arlington High School Building with an associated paved driveways, landscaped areas, and utilities as well as grass athletic fields, turf football field and facilities. There are several accessory structures across the property for equipment storage and bathroom facilities for the fields. The property is abutted by the Minuteman Commuter Bikeway on the north side, a condominium complex and pharmacy on the east side, and a series of residences and the Francis N. O'Hara building on the west side. The site slopes approximately 33 feet from south to north, with the high point of the site being at Massachusetts Ave., with the low point being on the east side of the site at the end of the Mill Brook culvert. Mill Brook flows through the site from west to east between the existing building and the football stadium via a subsurface concrete box culvert. which splits into two corrugated metal culverts on the east side of the existing building before daylighting on the east side of the site adjacent to Mill Street Drive.

The proposed project includes a new 143,025 square foot High School building footprint with associated new paved parking areas, landscaping, athletic fields, bathroom building, utilities and a new stormwater management system in accordance with the Massachusetts DEP Stormwater Standards. The existing football stadium will remain as is and is not included within the scope of this project.

1.1 Existing Conditions

The parcel for the Arlington High School is approximately 21.18± acres in size, Existing Conditions Plan Sheet EX1.1 – EX1.6 shows the entire site including the land use, topographic features, and identified resources areas. The project site is bounded to the north by a wooded area and the Minuteman Commuter Bikeway. To the east there is residential condominium development, a CVS Pharmacy and Mill Brook Drive. To the south of the project is Massachusetts Avenue. To the west of the project are residential buildings along Schuler Court and the Arlington Department of Public Works.

Plans C-1.0 – C-4.4 show the entire site including land use, topographic features, and identified resource areas.

1.2 Regional Context

Land use surrounding the property predominantly consists of commercial buildings and multi-family residential apartment buildings. Site Locus Plan Sketch in the Appendix depicts the context of the area in relation to the neighborhood.

1.3 Resource Areas

Wetland resources subject to jurisdiction under the Massachusetts Wetlands Protection Act and the Town of Arlington Wetlands Protection Bylaw were delineated by Epsilon Associates on July 15, 2019.

A summary of wetland resource areas is provided below and is included in the Appendix.

Riverfront Area:

Flags AB-1 to AB-15 and AB-111 to AB-115 delineate the Mean Annual High Water (MAHW) line of Mill Brook which flows away from the property to the east parallel to Mill Brook Drive. The stream is indicated as perennial, and is therefore presumed under 310 CMR 10.58 and the Arlington Wetlands Bylaw to contain a 200-foot Riverfront Area extending horizontally from the limits of MAHW.

Flag AB-15 and AB-115 are located west of the baseball field where Mill Brook is daylighted between two 6-foot wide concrete box culverts and approximately 5-feet downstream Mill Brook enters the project site before being culverted beneath the school facility. Approximately 1,000 feet downstream are flags AB-13 and AB-113 where Mill Brook daylights again through a concrete reinforced double corrugated plastic culvert. Approximately 200 feet downstream are flags AB-1 and AB-101 where Mill Brook flows under a 15-foot wide concrete bridge. The stream channel contains well defined and vegetated bank, separated from the project site by a chain link fence. MAHW was determined based upon bankfull indicators, including changes in slope, undercut banks and clear changes in vegetation from primarily aquatic to primarily terrestrial.

Riverfront Area regulations contained within 310 CMR 10.58 generally require a 100-foot zone of natural undisturbed vegetation unless this area has been previously developed or degraded, such as by filling, paving or construction of other structures. Construction proposed in the Riverfront Area must also demonstrate that there are no other alternatives with lesser impact to the river. New alterations of Riverfront Area must be under 5,000 square feet or 10% of the total Riverfront Area on the parcel, whichever is greater. In the case of proposed redevelopment of previously degraded areas, alterations must not exceed that of the total degraded area.

Inland Bank

The limits of Inland Bank resource associated with Mill Brook was determined to be coincident with the limit of MAHW defining Riverfront Area as described above. The top of Bank is defined under state and local regulations as the first observable break in slope above the water, or mean high water, whichever is lower. The bank at the project site generally consists of 1-2 foot high steep or nearly vertical slope vegetated with small trees and shrubs. The top of the Bank is at a clear break in slope above the water.

There is a 100-foot Buffer Zone associated with Inland Banks under state and local regulations.

Bordering Vegetated Wetland (BVW):

Flag series AB-1 to AB-13 and AB-101 to AB-113 delineates the limits of a BVW extending from the brooks described above. Vegetation along the banks consisted of honey locust (Gleditsia triacanthos), black willow (Salix nigra), Norway maple (Acer platanoides), white oak (Quercus alba), silver maple (Acer saccharinum), white ash (Fraxinus Americana), slippery elm (Ulmus rubra), staghorn sumac (Rhus typhina), Japanese knotweed (Reynoutria japonica), glossy buckthorn (Frangula alnus), garlic mustard (Alliaria petiolate), and Asian bittersweet (Celastrus orbiculatus). The substrate consisted of pebbles and cobbles, which formed riffle pools. The water ran clear, at about four inches to two feet deep. The steep soil banks transitioned to rock wall between flags AB-11 to AB-13 on the southern bank. Mill Brook flowed east through a 15-foot wide concrete bridge between flags AB-1 and AB-101. A concrete

reinforced double corrugated plastic culvert was located between flags AB-113 and AB-13. A 12-inch concrete reinforced pipe was located between flags AB-4 and AB-5.

Bank Series AB-114 to AB-115 and AB-14 to AB-15 was delineated in the western portion of the Study Area. This portion of Mill Brook is daylighted between two 6-foot wide concrete box culverts. This portion of the stream has a concrete substrate, and 5-foot vertical concrete banks. At the time of delineation, 2-4 inches of running water was observed. Vegetation along the top of these banks was dominated by northern catalpa (Catalpa speciose), Asian bittersweet, box elder, and garlic mustard.

Additional BVW is located in the southwest perimeter of the school property where two areas of wet meadow extend into mowed grass areas. These areas connect to wetlands and a small intermittent stream channel located off-site behind the residences on Brook Street. They were delineated by flags A-1 to A-5 and C-1 to C-9. Dominant vegetation includes rough-stem goldenrod (Solidago rugosa), purple loosestrife (Lythrum salicaria), spotted joe-pye weed (Eupatoriadephus maculates) and jewelweed (Impatiens capensis). Adjacent uplands consist of mowed lawn.

Bordering Land Subject to Flooding (BLSF):

The current Federal Emergency Management Agency ("FEMA") Flood Insurance Rate Maps ("FIRM") dated 6/4/2010 Community Panel Numbers 0417E and 0416E for the Town of Arlington indicate that portions of the Study Area are located within the 100-year floodplain. The 100-year floodplain is regulated as BLSF under the local and state wetlands regulations. A regulatory floodway also covers a portion of Mill Brook to the east. The base flood elevation identified in the FEMA FIRM (elev. 42-feet) is shown on the existing and proposed conditions permit drawings to delineate the edge of BLSF.

1.5 Riverfront Alternatives

Alternative 1: Renovation Only
An alternative to the selected option is to renovate the existing School, along with additions to the existing school. This would not meet the criteria to allow for the District's educational vision for the school.

Alternative 2: Additions and Renovations
Another alternative to this project is to renovate portions of the existing school and add on additions to the structure. This would not meet the criteria for the District's educational vision for the school – leaving many critical elements of the educational plan unaddressed. These alternatives also leave the existing previously disturbed areas (parking, etc.) as is, thus not improving the Riverfront Area from its current condition.

Alternative 3: No Build
The proposed School would not be built in this scenario. This does not meet the program requirements for the school / district.

Additionally, during the MSBA feasibility study, the team investigated multiple layouts for suitable solutions for the site. It was determined through that study that the selected alternative best met the programmatic requirements while accommodating the physical constraints of the parcel (resource areas, size, shape, slopes, etc.).

1.6 Wildlife Habitats

The project site is **NOT** located within Priority Habitat or Estimated Habitat of Rare Wetlands Wildlife as determined by reference to data provided by the Mass. Division of Fisheries and Wildlife – Natural Heritage and Endangered Species Program (NHESP) available on MassGIS.

Included in the Appendix is a sketch depicting that the site is not within Priority Habitat or Estimated Habitat of Rare Wetlands Wildlife.

2.0 Project Description

The proposed project will consist of constructing a new school building off of the south face of the existing building and extending north into the footprint of the existing building.

Due to the proposed building location the existing driveway off of Mill Brook Drive will be realigned to provide a drop off area for parents/ students, a delivery entrance for trucks, and several parking spaces and handicapped parking spaces. The driveway will continue around the school and provide access to additional parking to the west and Massachusetts Ave. via Schuler Court. The athletic fields to the north and northwest shall be reconstructed with infill turf and provide accessible paths.

The Stormwater Report included with this submission (under separate cover) has a more in depth analysis of the hydrological function of the site.

3.0 Construction Impacts on areas subject to protection Under M.G.L. c. 131, § 40 and Town of Arlington Regulations for Wetlands Protection bylaw.

3.1 Inland Bank [310 CMR 10.54]

No activities are proposed within Inland bank.

3.2 Bordering Vegetated Wetlands [310 CMR 10.55]

Preamble:
Bordering Vegetated Wetlands are likely to be significant to public or private water supply, to ground water supply, to flood control, to storm damage prevention, to prevention of pollution, to the protection of fisheries and to wildlife habitat. The plants and soils of Bordering Vegetated Wetlands remove or detain sediments, nutrients (such as nitrogen and phosphorous) and toxic substances (such as heavy metal compounds) that occur in run-off and flood waters. The profusion of vegetation in Bordering Vegetated Wetlands acts to slow down and reduce the passage of flood waters during periods of peak flows by providing temporary flood water storage and by facilitating water removal through evaporation and transpiration. This process reduces downstream flood crests and resulting damage to private and public property. During dry periods the water retained in Bordering Vegetated Wetlands is essential to the maintenance of base flow levels in rivers and streams, which in turn is important to the protection of water quality and water supplies.

Performance Standard:
No work is proposed to the Bordering Vegetated Wetland (BVW).

3.3 Buffer Zones [310 CMR 10.02]

Preamble:

Extensive work in the inner portion of the buffer zone, particularly clearing of natural vegetation and soil disturbance is likely to alter the physical characteristics of resource areas by changing their soil composition, topography, hydrology, temperature, and the amount of light received. Soil and water chemistry within resource areas may be adversely affected by work in the buffer zone. Alterations to biological conditions in adjacent resource areas may include changes in plant community composition and structure, invertebrate and vertebrate biomass and species composition, and nutrient cycling. These alterations from work in the buffer zone can occur through the disruption and erosion of soil, loss of shading, reduction in nutrient inputs, and changes in litter and soil composition that filters runoff, serving to attenuate pollutants and sustain wildlife habitat within resource areas.

Performance Standards:

The wetland buffer zones consist of mixed uses; a portion of the area has been previously disturbed and contain portions of the paved driveway, paved parking lot, concrete slabs for bleachers, unpaved athletic field, granite curbing, and grassed areas.

Proposed buffer zone construction will include grading, demolition & removal of the existing pavement and curbs, repaving a new driveway and parking lot and construction of stormwater and other underground utilities. Work is not proposed to encroach closer within the buffer than what is currently disturbed.

To mitigate the potential for adverse impacts on the resource area caused by work in the buffer zones during construction, a detailed soil erosion and sediment control plan has also been established for all phases of construction.

3.4 Bordering Land Subject to Flooding (BLSF) [310 CMR 10.02(2)(b)3]

Preamble:
Flood Plains are documented by the Federal Emergency Management Agency (formerly the Department of Housing and Urban Development - Federal Insurance Administration) for the Town of Arlington (Middlesex County) on the Flood Insurance Rate Map Community Panel Number 25017C0417E, with an effective date of June 4, 2010. This plan is depicted in the Appendix.

The boundary of BLSF is the estimated maximum lateral extent of flood water which will theoretically result from the statistical 100-year frequency storm. FEMA indicates that Mill Brook has been identified as a Zone AE. The base flood elevation identified in the FEMA Firm as the edge of the BLSF is 42-feet. According to FEMA flood mapping, the site is located within Zones X and AE (see FEMA Firmette Map within the appendices of this report). These flood zones are depicted graphically on the civil design plans and existing conditions plans per the FEMA delineation. However, after a field survey of elevations present at the site, we have concluded that the flood elevations shown on the FEMA mapping are held within the banks of the Mill Brook and do not encroach on the site. During the last major renovation at the school, there was a small area on the east side of the school dedicated for compensatory storage.

There is no buffer zone extending from this resource.

Performance Standards:

There is NO work occurring within Flood Zone AE per the actual elevations per the Flood Impact Study. There is a small compensatory storage area on the east side of the existing building that was for

a previous project but not defined by elevations or compensatory storage volumes. This area will be disturbed by the proposed High School project. The proposed project work, even though not within flood plain elevations as defined by FEMA or the WPA, will emulate the existing compensatory storage by providing compensatory storage within the stone of the turf fields that far exceed the volume held by the existing "Compensatory flood storage area".

3.5 Riverfront Area [310 CMR 10.58]:

Preamble:
Riverfront areas are likely to be significant to protect the private or public water supply; to protect groundwater; to provide flood control; to prevent storm damage; to prevent pollution; to protect land containing shellfish; to protect wildlife habitat; and to protect the fisheries. Land adjacent to rivers and streams can protect the natural integrity of these water bodies. The presence of natural vegetation within riverfront areas is critical to sustaining rivers as ecosystems and providing these public values. In those portions so extensively altered by human activity that their important wildlife habitat functions have been effectively eliminated, riverfront areas are not significant to the protection of important wildlife habitat and vernal pool habitat.

Performance Standards:
The proposed work within the 200-foot Riverfront Area is not located closer to the river than the existing disturbed area which extends well into the 100-foot Inner Riparian zone.

The site has a total Riverfront Area of 34,667 s.f, consisting of 20,275 s.f. previously degrade land. The proposed work will disturb a total of 4,937 s.f. of non-degraded Riverfront Area. For the Inner Riparian Zone there will be 1,570 s.f. of disturbance with 100 s.f. of additional restored area from the existing condition. Within the outer Riparian Zone, an additional 3,168 s.f. will be altered. Wildlife friendly plantings and "low mow" meadow style grasses will also be utilized to improve on the current mowed landscape condition of the Riverfront Areas in the existing condition.

3.6 Town of Arlington Regulations for Wetlands Protection Section 31 Climate Change Resiliency:
The project integrates considerations of adaptation planning into the project to promote climate change resilience so as to protect and promote resource area values in the future. The overall project will meet LEED guidelines and be LEED certified including significantly improving energy demands (including as an example the use of photovoltaics) when compared to the exiting school. Additionally, the stormwater management will now met State and local standards including such Low Impact Development BMP's as Rain Gardens and

4.0 Soil Erosion and Sediment Control Plan

The objectives of the Soil Erosion and Sediment Control Plan are to control erosion at its source during construction activities, by applying temporary control structures, minimizing the runoff from areas of disturbance, and de-concentrating and distributing stormwater runoff through natural vegetation before discharging to critical zones such as streams or wetlands. Soil erosion control does not begin with the perimeter sediment trap. It begins at the source of the sediment the disturbed land areas, and extends down to the control structure.

The Soil Erosion and Sediment Control Plan will be enacted in order to protect the resource areas during construction. The erosion control devices will remain in place until all exposed areas have been stabilized with vegetation or impervious surfaces.

The objective of the Soil Erosion & Sediment Control Plan that will be enacted on site is to control the vulnerability of the soil to the erosion process or the capability of moving water to detach soil particles during the construction phase(s).

A. The Contractor shall submit a copy of the SWPPP and accompanying erosion and sediment control plan prior to commencing work.

B. The Contractor shall implement all soil erosion and sediment control devices prior to excavation within the site.

C. The following erosion control principles shall apply to the land grading and construction phases:
   - Stripping of vegetation, grading, or other soil disturbance shall be done in a manner which will minimize soil erosion.
   - Whenever feasible, natural vegetation shall be retained and protected.
   - Extent of area which is exposed and free of vegetation and duration of its exposure shall be kept within practical limits.
   - Temporary seeding, mulching, or other suitable stabilization measures shall be used to protect exposed critical areas during prolonged construction or other land disturbance.
   - Sediment shall be retained on-site.
   - Erosion control devices shall be installed as early as possible in the construction sequence prior to the start of grubbing and earthwork operations and excavation work.

4.1 Erosion Control Devices

1. Straw Wattles

Straw bales for construction of erosion control devices shall be new, firm, wire or nylon-bound livestock feed grade. The netting shall have a strand thickness of 0.03 inch, and a knot thickness of 0.055 and a weight of 0.35 ounce per foot (each +/- 10%) and shall be made from 85% high density polyethylene, 14% ethyl vinyl acetate and 1% color for UV inhibition. Straw Wattles shall be 9 inches in diameter (+/- one inch), twenty-five feet long (+/- 0.5 feet) and weigh approximately 35 pounds (+/- 10%).

Wattles shall be installed along the edge of resource areas adjacent to the proposed work. Wattles shall also be placed around the toe of stockpiles and at locations where grading is performed.

Installation and Maintenance

a. Wattles shall be installed as indicated on the drawing, prior to the start of grubbing and earthwork operations.
b. Wattles shall be new and shall be secured in place as shown on the plans.

c. Wattles shall be placed in a row with ends tightly abutting the adjacent wattles. Each wattles shall be securely anchored in place by 2 stakes or re-bars driven through the wattles. The first stake in each wattle shall be angled toward the previously laid wattles to force the wattles together

d. Sedimentation shall be removed from wattles barrier when sediment has accumulated to greater than 6 inches deep. Sediment deposits shall be disposed of in accordance with the SWPPP.

e. Wattles barrier(s) shall be inspected periodically and deteriorated wattles replaced until such time as construction is completed and exposed slopes have been stabilized.

f. Wattles barrier shall remain in place until exposed soils have been stabilized with a vegetative cover.

g. Wattles shall not be removed until approval is given by the Commission.

2. Siltation Fence

Geotextile Fabric shall consist of long-chain synthetic polymers, composed of at least 85% by weight polylefins, polyesters, or polymides. They shall be formed into a network such that the filaments or yarns retain dimensional stability relative to each other, including selvedges. The geotextile fabric shall have the following properties:

Property(ASTM Test Method)	**Unit**	**Typical Values**
Grab Strength (D-4632-86)	lbs	100
Grab Elongation (D-4632-86)	%	30(Max)
Trapezoid Tear Strength (D-4533-85)	lbs	65
Mullen Burst Strength (D-3786-80a)	psi	280
Coeff. of Permeability (D-4491-85)	cm/sec	0.01
Water Flow Rate (D-4491-85)	gal/min/(ft)(ft)	35
Ultraviolet Stability (D-4355-84)	%	90

Support fence posts shall be at least 48 inches high and strong enough to support applied loads. The Contractor shall have the option of using wood or metal posts. Wood posts shall consist of 1 ½" square, kiln dried, hardwood posts. Steel posts of U, T, L, or C shape weighing 1.3 pounds per linear foot may be substituted for wood. Filter fabric shall be attached to wood posts with staples and with 13 gage minimum, galvanized steel wire for steel post application.

Installation and Maintenance

a. Silt Fence shall be installed as indicated on the drawing, prior to the start of grubbing and earthwork operations.

b. The location of silt fence shall be reviewed and approved by the Commission.

c. Accumulation of siltation behind the fence shall be removed once the total depth of silt reaches 6".

Silt fence shall remain in place until directed to be removed by the Commission.

Areas disturbed after removal shall be regraded and seeded.

3. Catch Basin Filters

The filters will be manufactured to fit the opening of the catch basins, drywells, and Treepit inlets. The filters will have the following features:

- Two dump straps attached at the bottom to facilitate the emptying of the filters.
- The filters will also have lifting loops as an integral part of the system to be used to lift the filters from the basin.
- The filters will have a restraint cord approximately halfway up the sack to keep the sides away from the catch basin walls; this yellow cord shall also be a visual means of indicating when the sack should be emptied.
- Filters shall be removed once paving is completed but not prior to installation of oil hoods. Filters in landscaped areas (or subject to runoff from landscaped areas) shall remain until vegetation is established.

Installation and Maintenance

a. Silt sacks or approved equal shall be installed where shown on the plans.

b. Silt sacks or approved equal shall be installed in all new drain lets as soon as the structure is installed.

c. Once the strap is covered the filter shall be emptied, cleaned and reinstalled.

4. Construction Entrance

The construction entrance shall consist of filter fabric, a layer of clean, crushed stone, ranging from 1-1/2" to 2-1/2" in size, and a top dressing of clean 2" crushed stone. Geotextile Fabric shall consist of long-chain synthetic polymers, composed of at least 85% by weight polylefins, polyesters, or polymides. They shall be formed into a network such that the filaments or yarns retain dimensional stability relative to each other, including selvedges. The geotextile fabric shall have the following properties:

Property (ASTM Test Method)	Unit	Typical Values
Grab Strength (D-4632-86)	lbs	100
Grab Elongation (D-4632-86)	%	30 (Max)
Trapezoid Tear Strength (D-4533-85)	lbs	65
Mullen Burst Strength (D-3786-80a)	psi	280
Coeff. of Permeability (D-4491-85)	cm/sec	0.01
Water Flow Rate (D-4491-85)	gal/min/(ft)(ft)	35
Ultraviolet Stability (D-4355-84)	%	90

5. Dust Control

Water will be applied by sprinkler or water truck as necessary during grading operations in order to minimize sediment transport and maintain acceptable air quality conditions. Repetitive treatments will be done as needed until the grades are paved or seeded.

6. Temporary seed cover

Grass seed for temporary seed cover shall be the previous year's crop. Not more than 0.1% by weight shall be weed seed and not more than 1.75% by weight shall be crop seed. Seed shall be delivered to

the site in sealed containers, labeled with name of seed grower and seed formula, in form stated below. Seed shall be dry and free of mold. Seed shall meet the following requirements:

Species Name	% by Weight	Minimum % in Mixture	Minimum % Germination Purity
Chewing Fescue (Festuca Rubra Comutata)	25	85	97
Alta Fescue (Festuca Arundinacea)	30	85	97
Annual Rye Grass (Lolium Multiflorum)	20	90	98
Red Top (Agrostis Alba)	15	90	92
White Clover (Trifolium Repens)	10	90	98

Installation

a. At the Contractor's option, seed may be spread by the hydro-seeding method, utilizing power equipment commonly used for that purpose. Seed and mulch shall be mixed and applied to achieve application quantities specified herein for the conventional seeding method, with mulch applied at the rate of 2700 lb. dry weight of mulch per acre. A mulching machine, acceptable to the Civil Engineer, shall be equipped to eject the thoroughly wet mulch material at a uniform rate to provide the mulch coverage specified.

b. If the results of hydro-seeding are unsatisfactory, the mixture and/or application rates and methods shall be modified to achieve the desired results.

c. After the grass has appeared, all areas and parts of areas which fail to show a uniform stand of grass, for any reason whatsoever, shall be re-seeded repeatedly if necessary, until all areas are covered with a satisfactory growth of grass.

d. If seeding cannot be established due to weather conditions, jute mesh shall be placed on the surface to reduce soil erosion.

7. Jute Mesh

Jute mesh shall be a uniform, open, plain weave cloth of undyed and unbleached single jute yarn. The yarn shall be of a loosely twisted construction and it shall not vary in thickness more than one-half its normal diameter. Jute mesh shall be furnished in rolled strips and shall meet the following requirements:

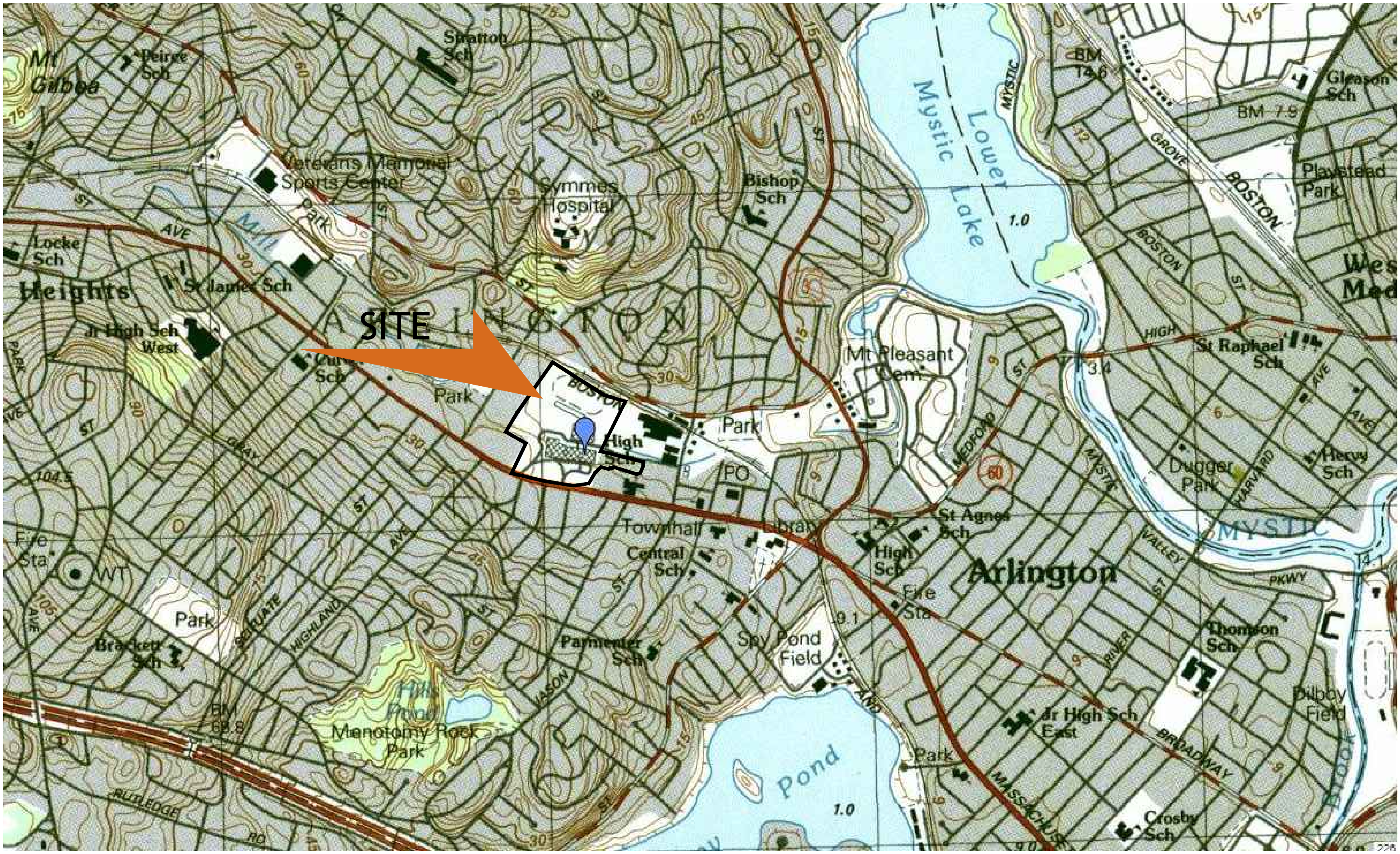
- Width - 48 inches, plus or minus one inch
- 78 warp - ends per width of cloth (minimum)
- 41 weft - ends per yard (minimum)
- Weight shall average 1.22 pounds per linear yard with a tolerance of plus or minus 5%.

Mesh shall be secure using U-shaped staples.

TABLE OF APPENDICES

APPENDIX 1:
ABUTTER NOTIFICATION LETTER
CERTIFIED ABUTTERS LIST

APPENDIX 2:
SKETCHES



Sketch No.	NOI-1
Reference Drawing	-

Job #:	17211.00
Drawn by:	DJS
Scale:	As Shown
Date:	05/05/20

Project: ARLINGTON HIGH SCHOOL

Title: LOCUS MAP

Samiotes Consultants Inc.
Civil Engineers + Land Surveyors

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Framingham, MA 01701

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Sketch No.	NOI-2
Reference Drawing	-

Job #:	17211.00
Drawn by:	DJS
Scale:	As Shown
Date:	05/05/20

Project: ARLINGTON HIGH SCHOOL

Title: NHESP MAP

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Civil Engineers + Land Surveyors

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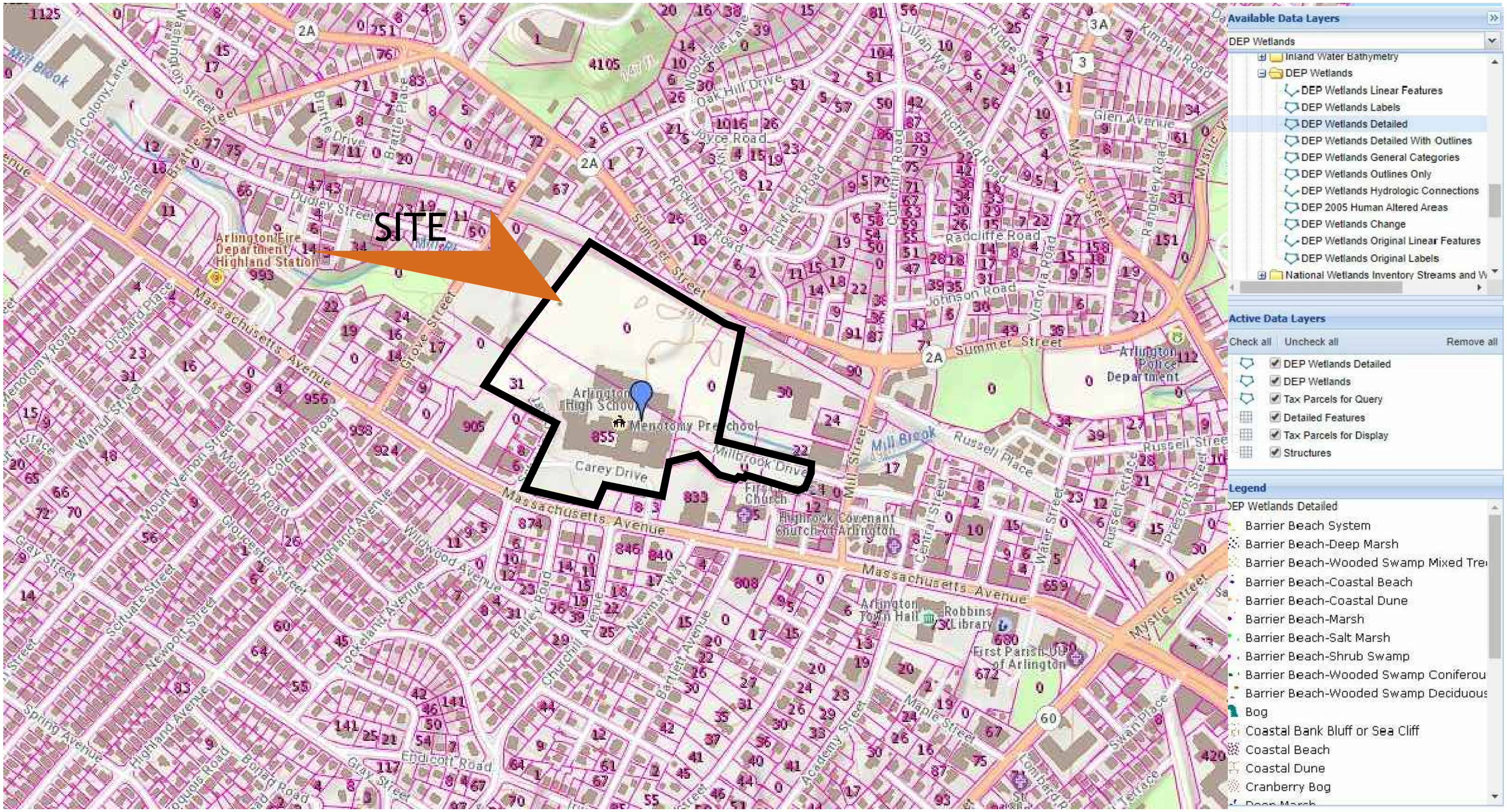

Sketch No.	NOI-3
Reference Drawing	-

Job #:	17211.00
Drawn by:	DJS
Scale:	As Shown
Date:	05/05/20

Project: ARLINGTON HIGH SCHOOL

Title: RESOURCE AREA MAP

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Sketch No.	NOI-4
Reference Drawing	-

Job #:	17211.00
Drawn by:	DJS
Scale:	As Shown
Date:	05/05/20

Project: ARLINGTON HIGH SCHOOL

Title: Zone I, Zone II, Zone A
Zone B, Zone C, IWPAs

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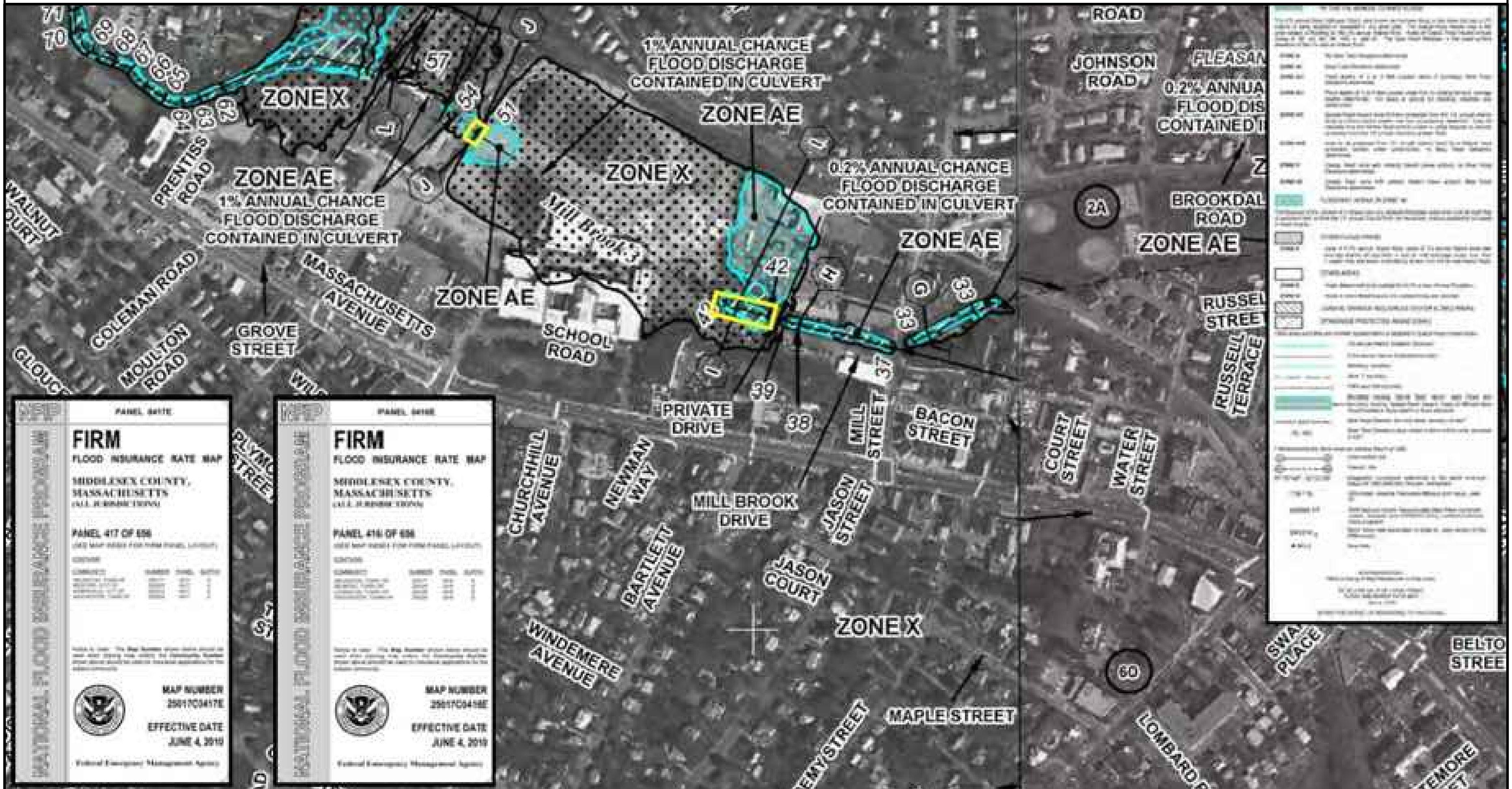

Sketch No.	
NOI-5	
Reference Drawing	-

Job #:	17211.00
Drawn by:	DJS
Scale:	As Shown
Date:	05/05/20

Project: ARLINGTON HIGH SCHOOL

Title: TOPOGRAPHIC LOCUS MAP

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PICTURE 1: CULVERT HEADWALL EAST SIDE OF SITE

PICTURE 2: CULVERT HEADWALL EAST SIDE OF SITE

PICTURE 3: **CULVERT HEADWALL WEST SIDE OF SITE**

PICTURE 4: **EXISTING DEPRESSION (HISTORICAL COMPENSATORY STORAGE)**

PICTURE 5: TOP OF HEADWALL EAST SIDE OF SITE

PICTURE 6: WETLAND RESOURCE AREA EAST PARKING LOT ALONG MILL BROOK

PICTURE 7: WETLAND RESOURCE AREA EAST PARKING LOT ALONG MILL BROOK

PICTURE 8: WETLAND RESOURCE AREA EAST PARKING LOT

PICTURE 9: MILL BROOK AT EAST HEADWALL

PICTURE 10: BRIDGE OVER MILL BROOK AT CONDOMINIUMS

APPENDIX 3:
WETLANDS REPORT

MEMORANDUM

Date: July 24, 2019

To: Mr. Stephen Garvin, P.E., President
Samiotes Consultants, Inc.

From: Amanda Atwell and Carolyn Gorss, Epsilon Associates Inc.

Subject: Wetland Delineation Memo: Arlington High School. Arlington, MA.

Overview

Epsilon Associates, Inc. ("Epsilon") prepared this memo for Samiotes Consultants, Inc. for wetland resource areas delineated on a portion of Arlington High School, located off Mill Brook Drive in Arlington, MA (the "Study Area"). This report describes the resource areas delineated by Epsilon on July 15, 2019. The wetland sketch provided in Attachment C depicts the approximate locations of the delineated wetland resource areas by Epsilon, to be survey-located by Samiotes.

As described in further detail below, wetland resource areas identified by Epsilon within the Study Area include Bordering Land Subject to Flooding ("BLSF"), Inland Bank ("Bank"), Land Under Water ("LUW") and Riverfront Area ("RFA") associated with Mill Brook, a USGS mapped perennial stream.

Existing Site Conditions

The Study Area consists of the Arlington High school campus in Arlington, MA, where Mill Brook intersects the athletic fields, depicted in Figures 1, 2 and 5 of Attachment A. Mill Brook is a perennial stream that is culverted underneath several of the Arlington High School athletic fields, including a turf field, softball field, and soccer pitch. Mill Brook daylights in the eastern & western portions of the property. The Study Area is bordered to the west by the Arlington Inspectional Services Department, and to the east by apartment buildings, Mill Brook Drive, and parking lots. The northern edge of the Study Area is bordered by steep upland slopes leading to the Minuteman Commuter Bikeway. Academic buildings are located in the southern portion of the Study Area, bordered by Massachusetts Avenue.

Mill Brook flows away from the property to the east under a 15-foot wide concrete bridge, parallel to Mill Brook Drive. The stream is described in more detail below. The site photographs in Attachment B depict existing conditions within the Study Area at the time of delineation.

The current Federal Emergency Management Agency ("FEMA") Flood Insurance Rate Maps ("FIRM") dated 6/4/2010 Community Panel Numbers 0417E and 0416E for the Town of Arlington indicate that portions of the Study Area are located within the 100-year floodplain (see Attachment A, Figure 4). The 100-year floodplain is regulated as BLSF under the local and state wetlands regulations. A regulatory floodway also covers a portion of Mill Brook to the east. The base flood elevation identified in the FEMA FIRM (elev. 42-feet) should be added to the existing and proposed conditions permit drawings to delineate the edge of BLSF.

According to the Natural Heritage and Endangered Species Program (Natural Heritage Atlas, 2017), there are no mapped Priority and Estimated Habitats within the Study Area.

Wetland Delineation Methodology

Wetland resource areas were delineated in the Study Area by Epsilon on July 15, 2019. The banks of Mill Brook, Series AB, were delineated using visible markings or changes in the character of soils or vegetation due to the prolonged presence of water, as defined in 310 CMR 10.58(2), 310 CMR 10.54(2), and the Town of Arlington Bylaw's definition of "Bank" in Section 9C of Article 8. More specifically, the upper boundary of a Bank is the first observable break in the slope or the mean annual flood level, whichever is lower. The lower boundary of a Bank is the mean annual low flow level. The Mean Annual High Water ("MAHW") of a perennial stream is apparent from visible markings or changes in the character of soils or vegetation due to the prolonged presence of water and that distinguishes between predominantly aquatic and predominantly terrestrial land. The first observable break in slope is typically coincident with the MAHW line. Land Under Water Bodies is assumed to be contained below Inland Bank and within the approximate mean low water levels in the stream.

Wetland Resource Areas - Definitions

In addition to BLSF described above, the following wetland resource areas were delineated in the field:

Land Under Water:

According to 310 CMR 10.56, LUW is the land beneath any creek, river, stream, pond or lake. Said land may be composed of organic muck or peat, fine sediments, rocks or bedrock. The boundary of Land Under Water Bodies and Waterways is the mean annual low water level. LUW is likely to be significant to public and private water supply, to ground water supply, to flood control, to storm damage prevention, to prevention of pollution and to protection of fisheries and wildlife habitat. Where such land is composed

of concrete, asphalt or other artificial impervious material, said land is likely to be significant to flood control and storm damage prevention.

Land Under Water within the Project Area is associated with Mill Brook, a perennial stream.

Inland Bank:

According to 310 CMR 10.54, an Inland Bank ("Bank") is the portion of the land surface which normally abuts and confines a water body. It occurs between a water body and a vegetated bordering wetland and adjacent flood plain, or, in the absence of these, it occurs between a water body and upland. The upper boundary of a Bank is the first observable break in the slope or the mean annual flood level, whichever is lower. The lower boundary of a Bank is the mean annual low flow level. Banks are likely to be significant to public or private water supply, to ground water supply, to flood control, to storm damage prevention, to the prevention of pollution and to the protection of fisheries and wildlife habitat. Where Banks are composed of concrete, asphalt or other artificial impervious material, said Banks are likely to be significant to flood control and storm damage prevention. There is a 100-foot Buffer Zone associated with Inland.

Inland Bank in the Study Area is associated with Mill Brook. The wetland sketch in Attachment C depicts the locations of flags delineating the banks of the daylighted portions of Mill Brook.

Riverfront Area:

According to 310 CMR 10.58, a Riverfront Area is the area of land between a river's mean annual high water line and a parallel line measured horizontally. The riverfront area may include or overlap other resource areas or their buffer zones. The riverfront area does not have a buffer zone. Riverfront areas are likely to be significant to protect the private or public water supply; to protect groundwater; to provide flood control; to prevent storm damage; to prevent pollution; to protect land containing shellfish; to protect wildlife habitat; and to protect the fisheries. The RFA extends 200 feet horizontally from the mean annual high water line of Mill Brook. It does not extend from the portion of the river that is culverted beneath the school facility (meaning, it is only associated with the stretch of river that is daylighted).

Wetland Resource Areas

Epsilon delineated two sections of Bank associated with Mill Brook within the Study Area. Bank Series AB-1 to AB-13 and AB-101 to AB-113 was located in the eastern portion of the Study Area, parallel to Mill Brook Drive. Vegetation along the banks consisted of honey locust (*Gleditsia triacanthos*), black willow (*Salix nigra*), Norway maple (*Acer platanoides*), white oak (*Quercus alba*), silver maple (*Acer saccharinum*), white ash (*Fraxinus Americana*), slippery elm (*Ulmus rubra*), staghorn sumac (*Rhus typhina*), Japanese knotweed (*Reynoutria japonica*), glossy buckthorn (*Frangula alnus)*, garlic mustard (*Alliaria petiolate*), and Asian bittersweet (*Celastrus orbiculatus*). The substrate consisted of pebbles and cobbles, which formed riffle pools. The water ran clear, at about four inches to two feet deep. The steep soil banks transitioned

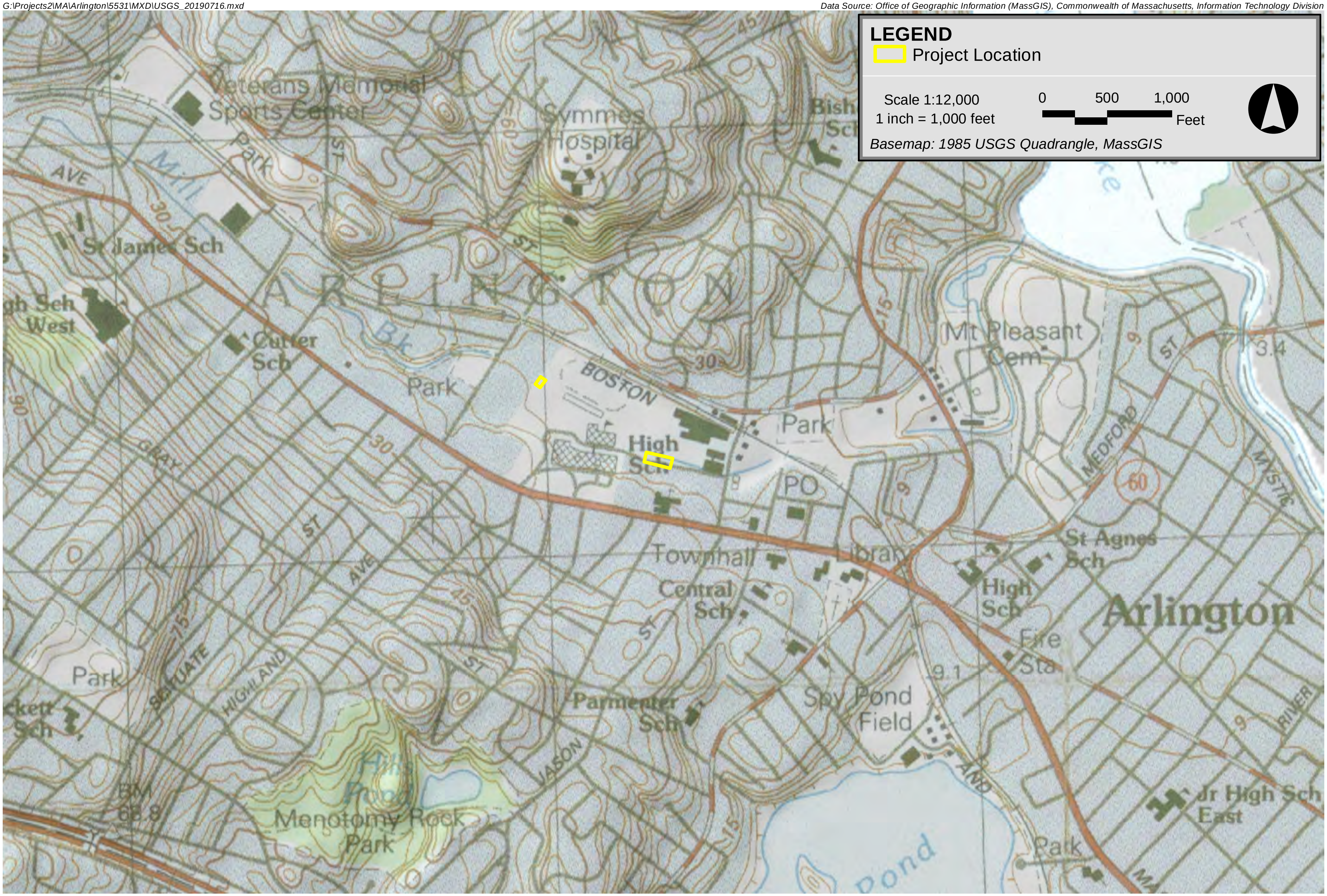
to rock wall between flags AB-11 to AB-13 on the southern bank. Mill Brook flowed east through a 15-foot wide concrete bridge between flags AB-1 and AB-101. A concrete reinforced double corrugated plastic culvert was located between flags AB-113 and AB-13. A 12-inch concrete reinforced pipe was located between flags AB-4 and AB-5.

Bank Series AB-114 to AB-115 and AB-14 to AB-15 was delineated in the western portion of the Study Area. This portion of Mill Brook is daylighted between two 6-foot wide concrete box culverts. This portion of the stream has a concrete substrate, and 5-foot vertical concrete banks. At the time of delineation, 2-4 inches of running water was observed. Vegetation along the top of these banks was dominated by northern catalpa *(Catalpa speciose),* Asian bittersweet, box elder, and garlic mustard.

Attachment A

Figures

Data Source: Office of Geographic Information (MassGIS), Commonwealth of Massachusetts, Information Technology Division



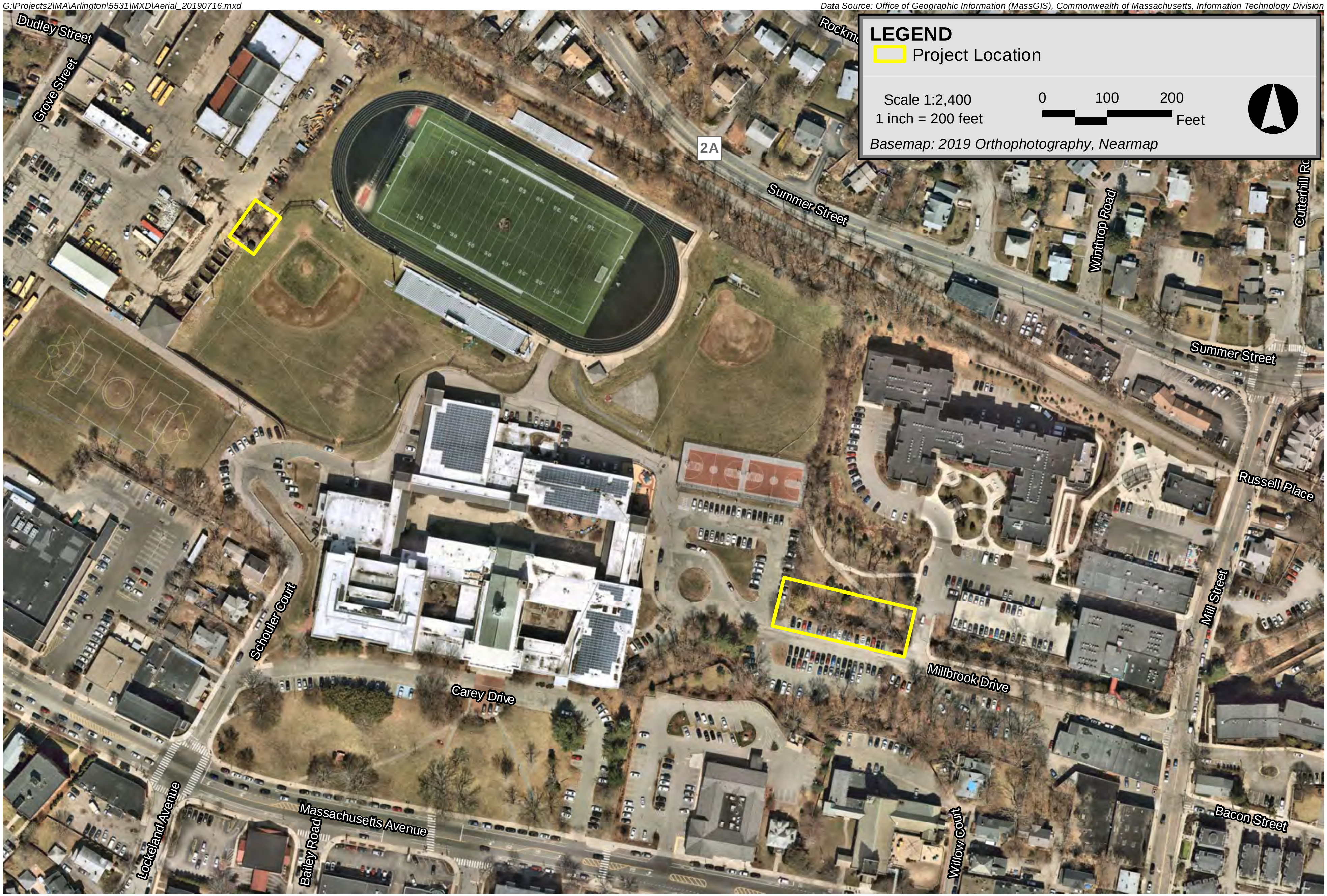
Arlington High School Wetland Delineation **Arlington, Massachusetts**

Epsilon ASSOCIATES INC.

Figure 1
USGS Locus Map

G:\Projects2\MA\Arlington\5531\MXD\Aerial_20190716.mxd

Data Source: Office of Geographic Information (MassGIS), Commonwealth of Massachusetts, Information Technology Division



Arlington High School Wetland Delineation **Arlington, Massachusetts**

Epsilon Associates Inc.

Figure 2
Aerial Locus Map

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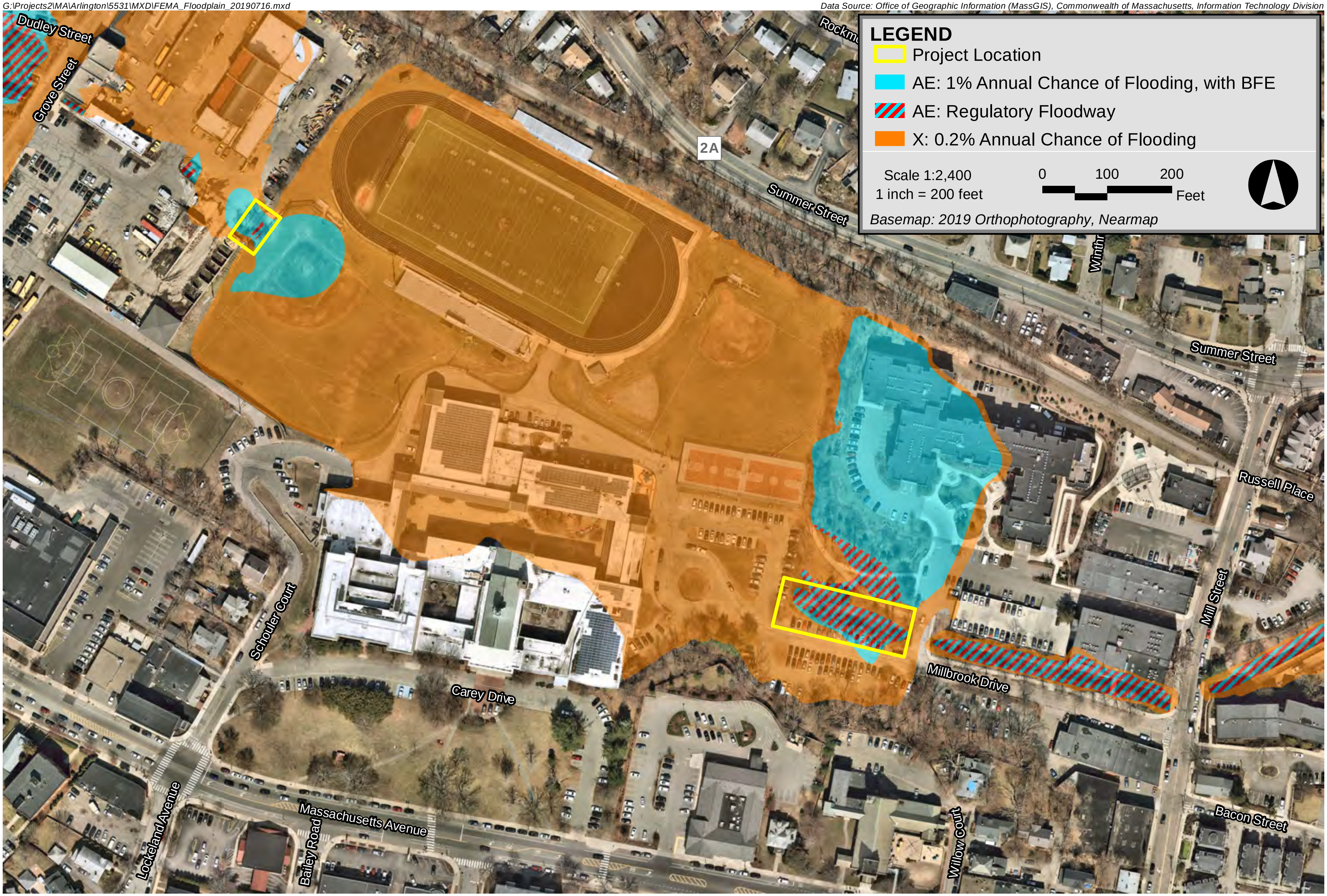
Data Source: Office of Geographic Information (MassGIS), Commonwealth of Massachusetts, Information Technology Division



Arlington High School Wetland Delineation Arlington, Massachusetts

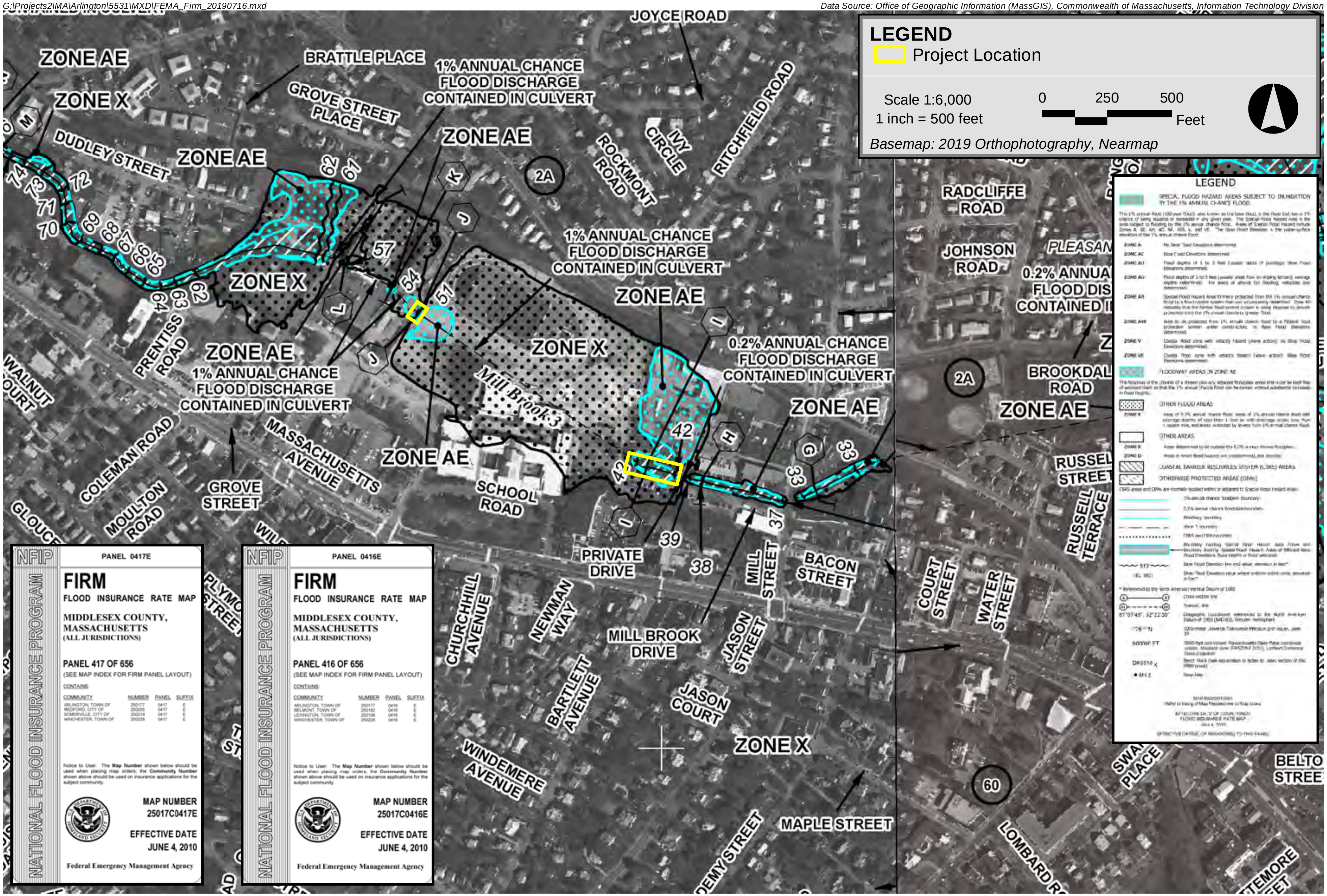
Epsilon ASSOCIATES INC.

Figure 3

FEMA Floodplain Map

G:\Projects2\MA\Arlington\5531\MXD\FEMA_Firm_20190716.mxd

Data Source: Office of Geographic Information (MassGIS), Commonwealth of Massachusetts, Information Technology Division



Arlington High School Wetland Delineation **Arlington, Massachusetts**

Epsilon ASSOCIATES INC.

Figure 4

FEMA FIRM Map

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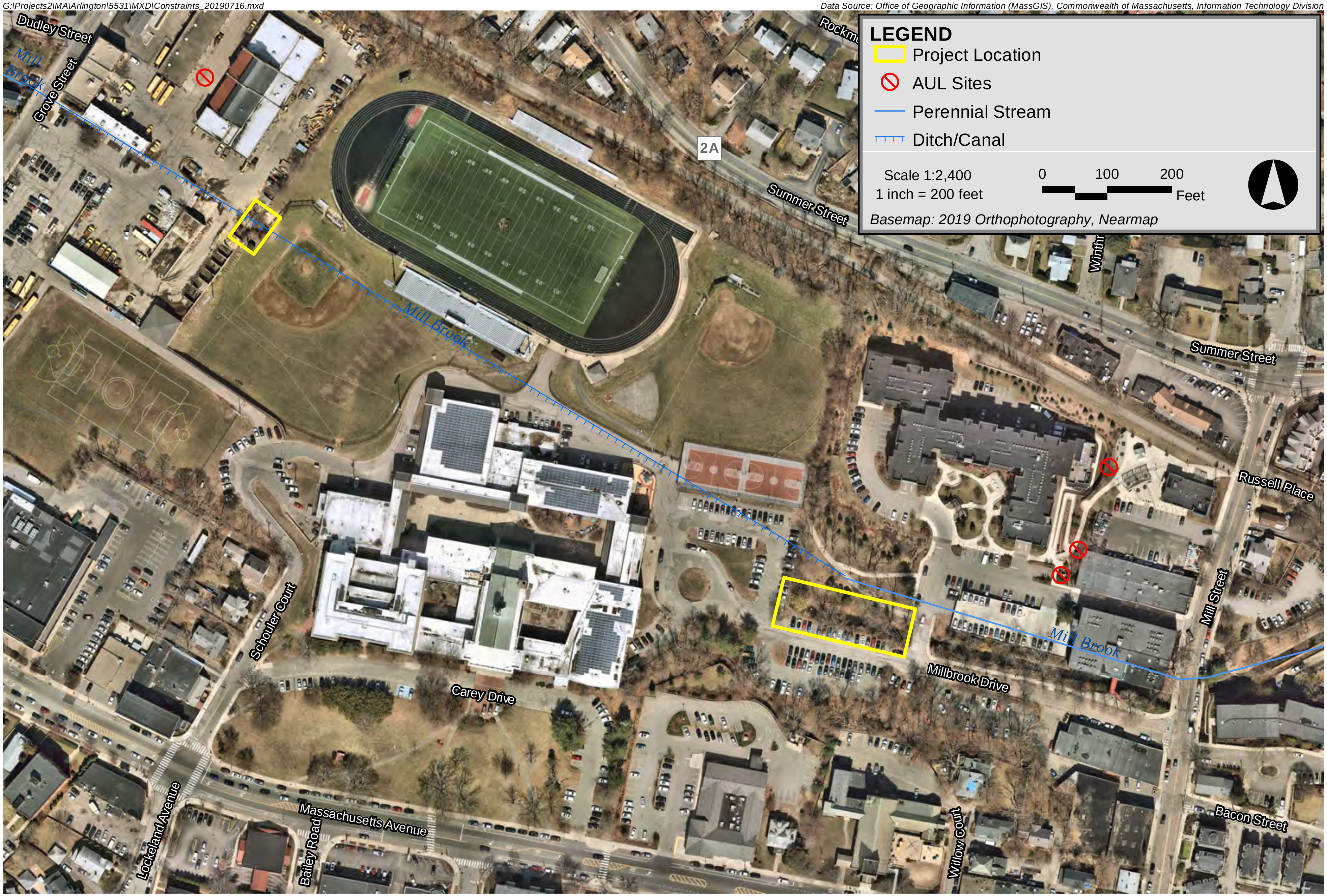
Data Source: Office of Geographic Information (MassGIS), Commonwealth of Massachusetts, Information Technology Division



Arlington High School Wetland Delineation **Arlington, Massachusetts**

Epsilon ASSOCIATES INC.

Figure 5

Environmental Constraints Map

Attachment B

Site Photographs

Photo 1. View of Bank Series AB from the concrete bridge between flags AB-1 and AB-101, looking west.

Photo 2. View of Bank Series AB between flags AB-3 and AB-103, looking east towards the concrete bridge connected to Mill Brook Drive.

Photo 3. View of stone wall bank, looking southeast near flag A-11 .

Photo 4. View of double culverts in Bank Series AB, looking east by bank flag AB-111.

Photo 5. View of culverted portion of the Mill River looking north. These storm drains were located to the west of the basketball courts at the end of Mill Brook Drive.

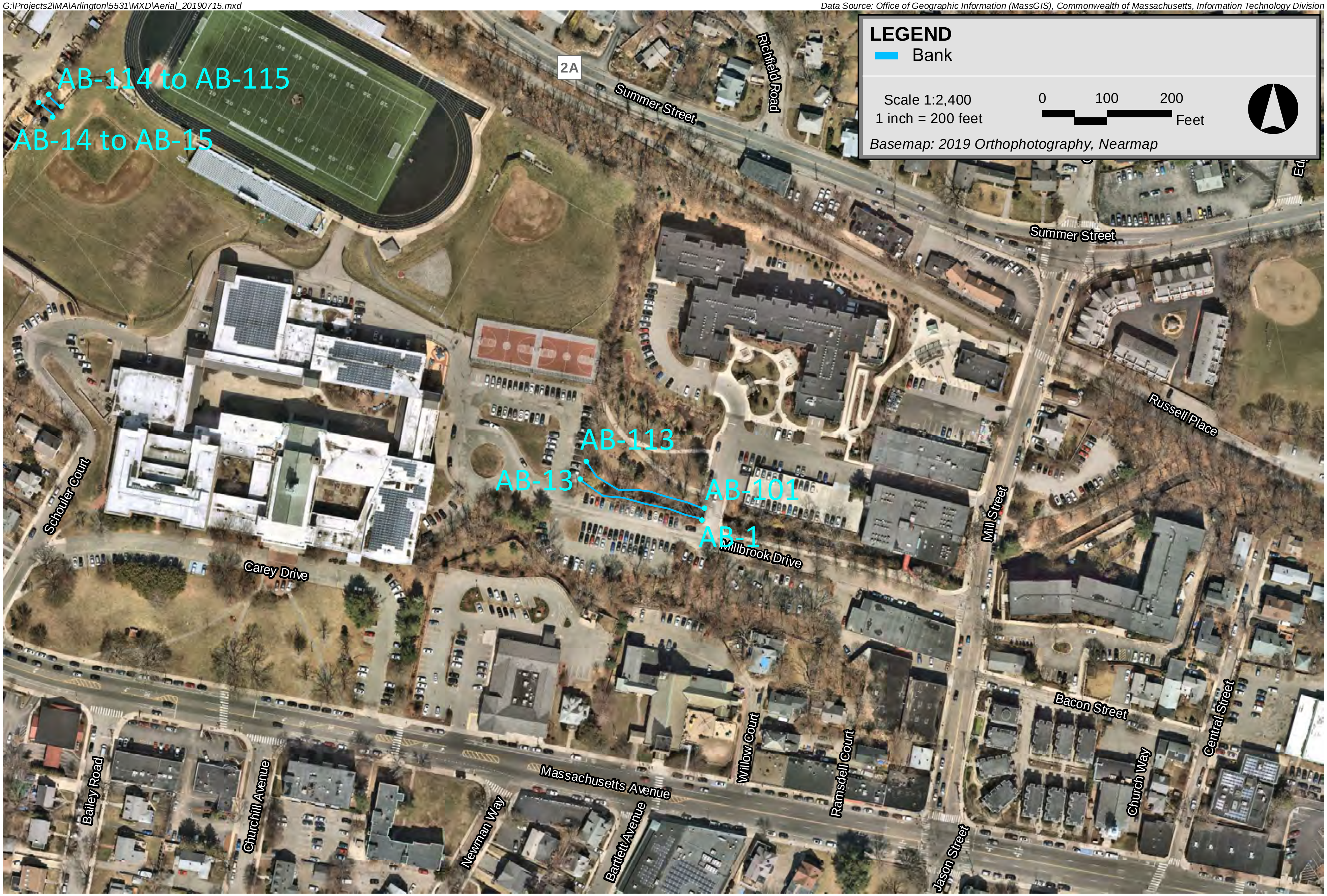
Photo 6. View of Series AB on the western portion of the study area, looking east. Flag AB-115 pictured in the bottom left of the photo.

Attachment A

Wetland Sketch

G:\Projects2\MA\Arlington\5531\MXD\Aerial_20190715.mxd

Data Source: Office of Geographic Information (MassGIS), Commonwealth of Massachusetts, Information Technology Division



Arlington High School Wetland Delineation **Arlington, Massachusetts**

Epsilon ASSOCIATES INC

Wetland Resources Sketch

APPENDIX 4:
DRAWING LIST

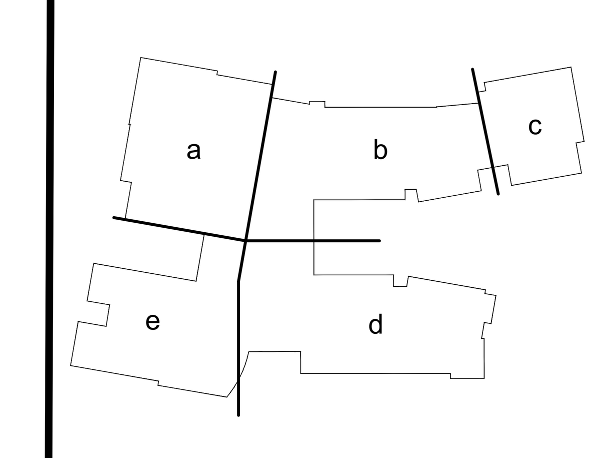
DRAWING LIST

Drawing	Title	Date
KEY	Existing Conditions Plan	05-04-2020
EX1.1	Existing Conditions Plan	05-04-2020
EX1.2	Existing Conditions Plan	05-04-2020
EX1.3	Existing Conditions Plan	05-04-2020
EX1.4	Existing Conditions Plan	05-04-2020
EX1.5	Existing Conditions Plan	05-04-2020
EX1.6	Existing Conditions Plan	05-04-2020
C-0.0	Cover Sheet	05-07-2020
C-1.0	Site Preparation and Erosion Control Plan	05-07-2020
C-2.0	Vehicular and Signage Plan	05-07-2020
C-3.0	Grading Plan	05-07-2020
C-4.0	Overall Utility Plan	05-07-2020
C-4.1	Utility Plan A	05-07-2020
C-4.2	Utility Plan B	05-07-2020
C-4.3	Utility Plan C	05-07-2020
C-4.4	Utility Plan D	05-07-2020
C-5.0	Details Sheet	05-07-2020
C-5.1	Details Sheet	05-07-2020
C-5.2	Details Sheet	05-07-2020

ARLINGTON HIGH SCHOOL PROJECT
NOTICE OF INTENT FILING
ARLINGTON CONSERVATION COMMISION

SHEET INDEX	
C-0.0	COVER SHEET
C-1.0	SITE PREPARATION & EROSION CONTROL PLAN
C-2.0	VEHICLE & SIGNAGE PLAN
C-3.0	GRADING PLAN
C-4.0	OVERALL UTILITY PLAN
C-4.1	UTILITY PLAN A
C-4.2	UTILITY PLAN B
C-4.3	UTILITY PLAN C
C-4.4	UTILITY PLAN D
C-5.0	DETAILS SHEET
C-5.1	DETAILS SHEET
C-5.2	DETAILS SHEET

KEYPLAN



REVISIONS NO.	DATE	REMARKS	BY

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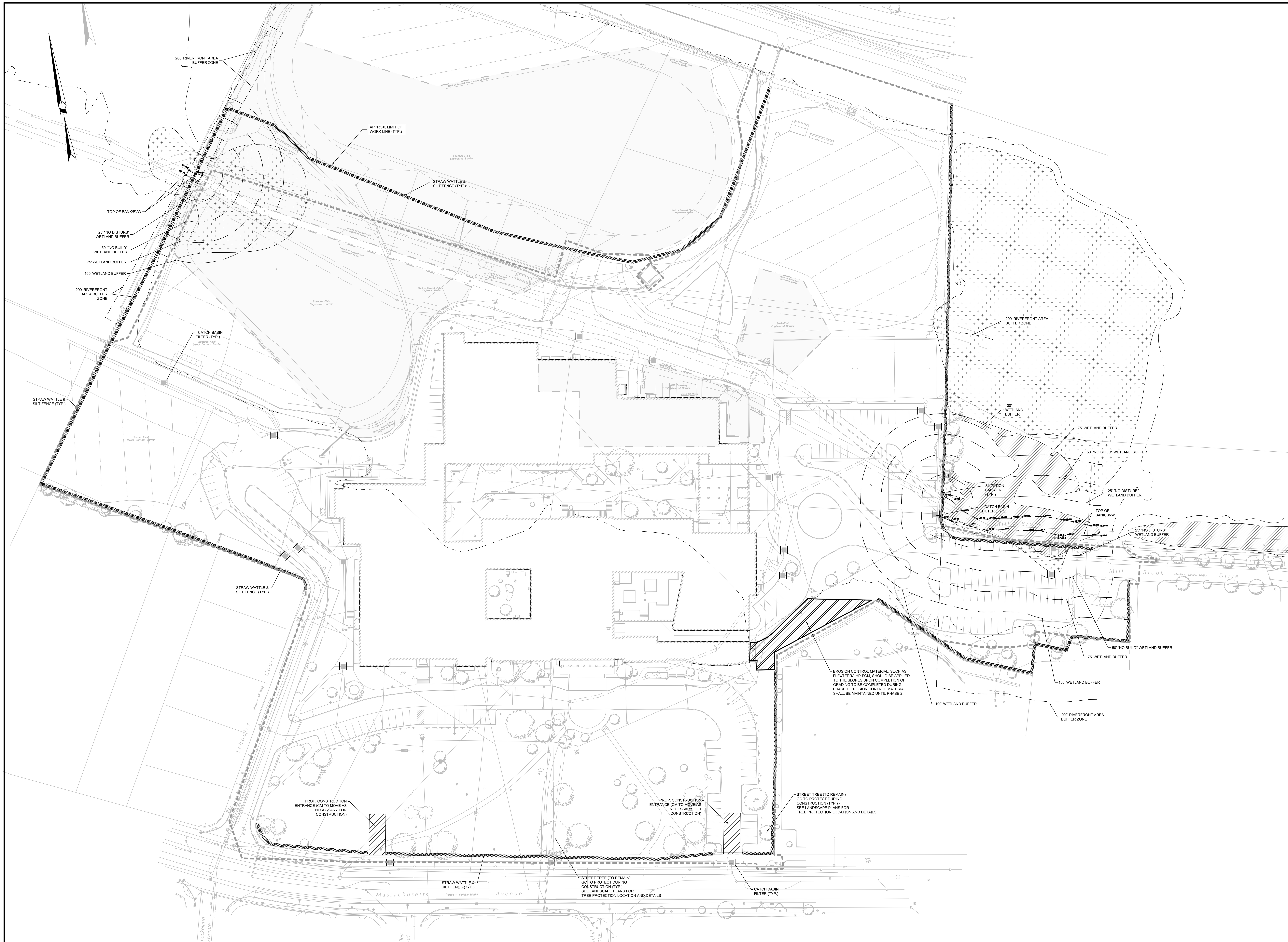
CONSERVATION COMMISSION FILING SET
05-07-2020

Arlington High School
Massachusetts Avenue, Arlington, Massachusetts
COVER SHEET

SCALE: 1"=40' DRAWN BY: SM CHECKED BY: SG

DRAWING NUMBER
C-0.0

JOB NUMBER 17211



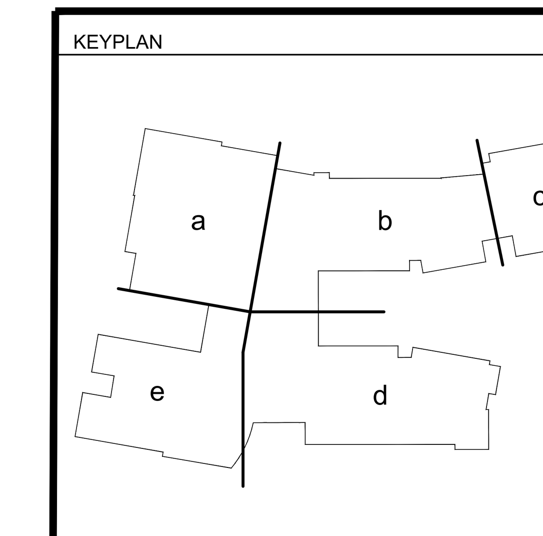
NOTE:
THE CONTRACTOR SHALL PHASE ALL DEMOLITION AND REMOVAL WORK TO ALLOW FOR THE CONTINUING OPERATION OF ALL STRUCTURES OUTSIDE OF LIMIT OF WORK.

NOTE:
DRAWING DOES NOT SHOW ENTIRE SCOPE OF DEMO. IT IS INTENDED TO AID CONTRACTOR WITH IDENTIFYING WORK AND IS NOT ALL INCLUSIVE.

LEGEND:
- TREE PROTECTION
- BUILDING TO BE REMOVED
- LIMIT OF WORK
- EROSION CONTROL
- PROPOSED CATCHBASIN FILTER

40 20 0 40 80
1 inch = 40feet

KEYPLAN



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CONSERVATION COMMISSION FILING SET
05-07-2020

Arlington High School
Massachusetts Avenue, Arlington, Massachusetts
SITE PREPARATION & EROSION CONTROL PLAN
SCALE: 1"=40' DRAWN BY: SM CHECKED BY: SG

DRAWING NUMBER
C-1.0
JOB NUMBER 17211

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05-07-2020

REVISIONS NO	DATE	REMARKS	BY

Arlington High School
Massachusetts Avenue, Arlington, Massachusetts
VEHICULAR & SIGNAGE PLAN

SCALE: 1"=40' DRAWN BY: SM CHECKED BY: SG

DRAWING NUMBER
C-2.0
JOB NUMBER 17211

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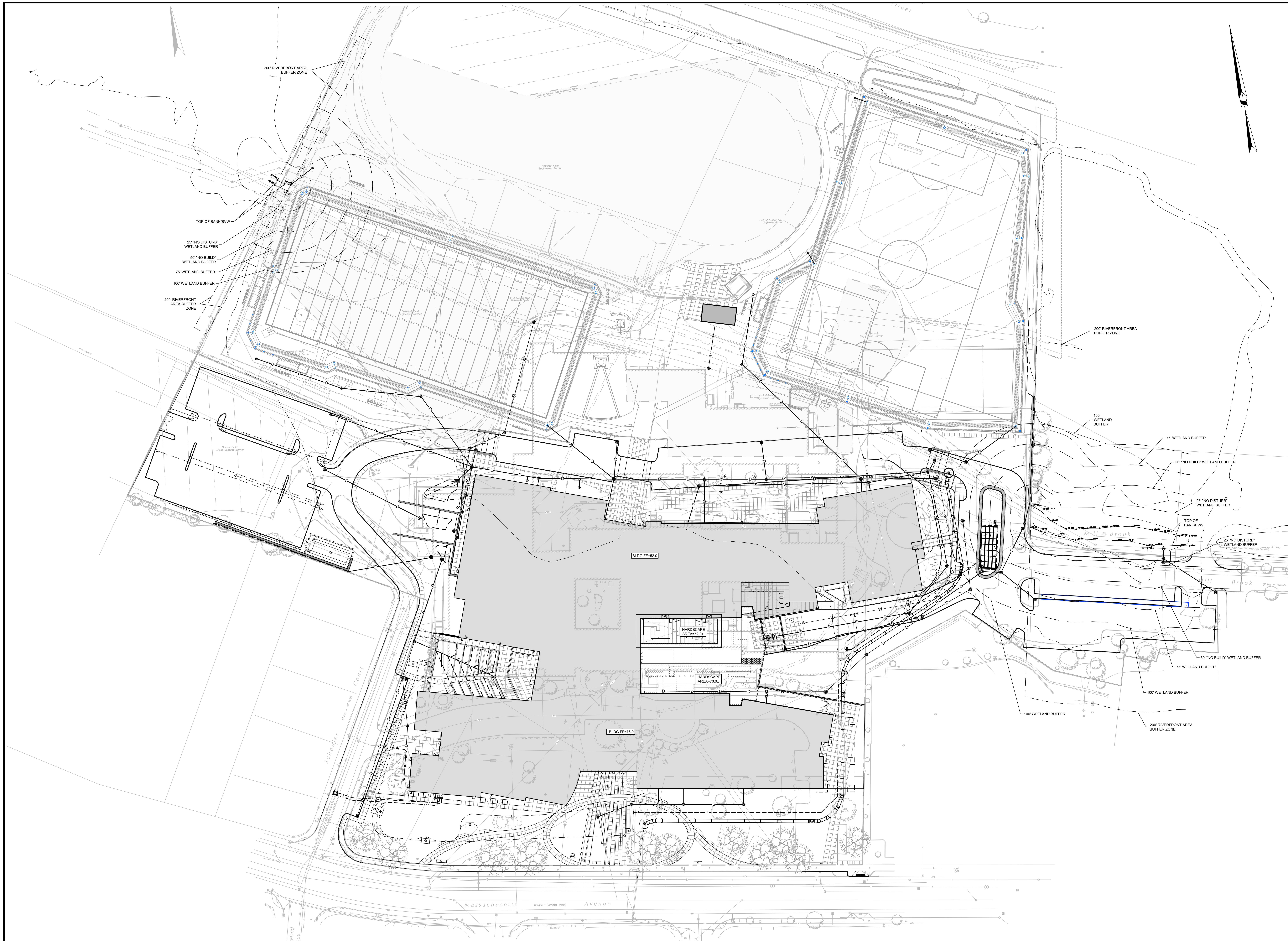
05-07-2020

Arlington High School
Massachusetts Avenue, Arlington, Massachusetts
GRADING PLAN

SCALE: 1"=40' DRAWN BY: SM CHECKED BY: SG

REVISIONS NO	DATE	REMARKS	BY

DRAWING NUMBER
C-3.0
JOB NUMBER 17211



LEGEND:

— D —	PROPOSED STORM DRAINAGE LINE
— W —	PROPOSED WATER LINE
— FP —	PROPOSED FIRE PROTECTION LINE
— SS —	PROPOSED SANITARY SEWER LINE
— G —	PROPOSED GAS LINE (BY OTHERS)
— E —	PROPOSED UNDERGROUND ELECTRIC LINE
SMH	PROPOSED SANITARY SEWER MANHOLE
DMH	PROPOSED STORM DRAINAGE MANHOLE
CB	PROPOSED CATCH BASIN
	PROPOSED HYDRANT
GV	PROPOSED GAS GATE VALVE
WV	PROPOSED WATER GATE VALVE
TSV	PROPOSED TAP AND SLEEVE VALVE
	APPROX. LOCATION OF ENGINEERED SOIL BARRIER

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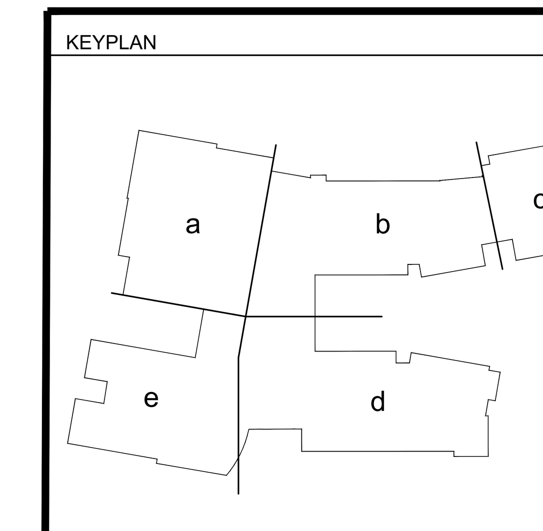
CONSERVATION COMMISSION FILING SET
05-07-2020

KEYPLAN

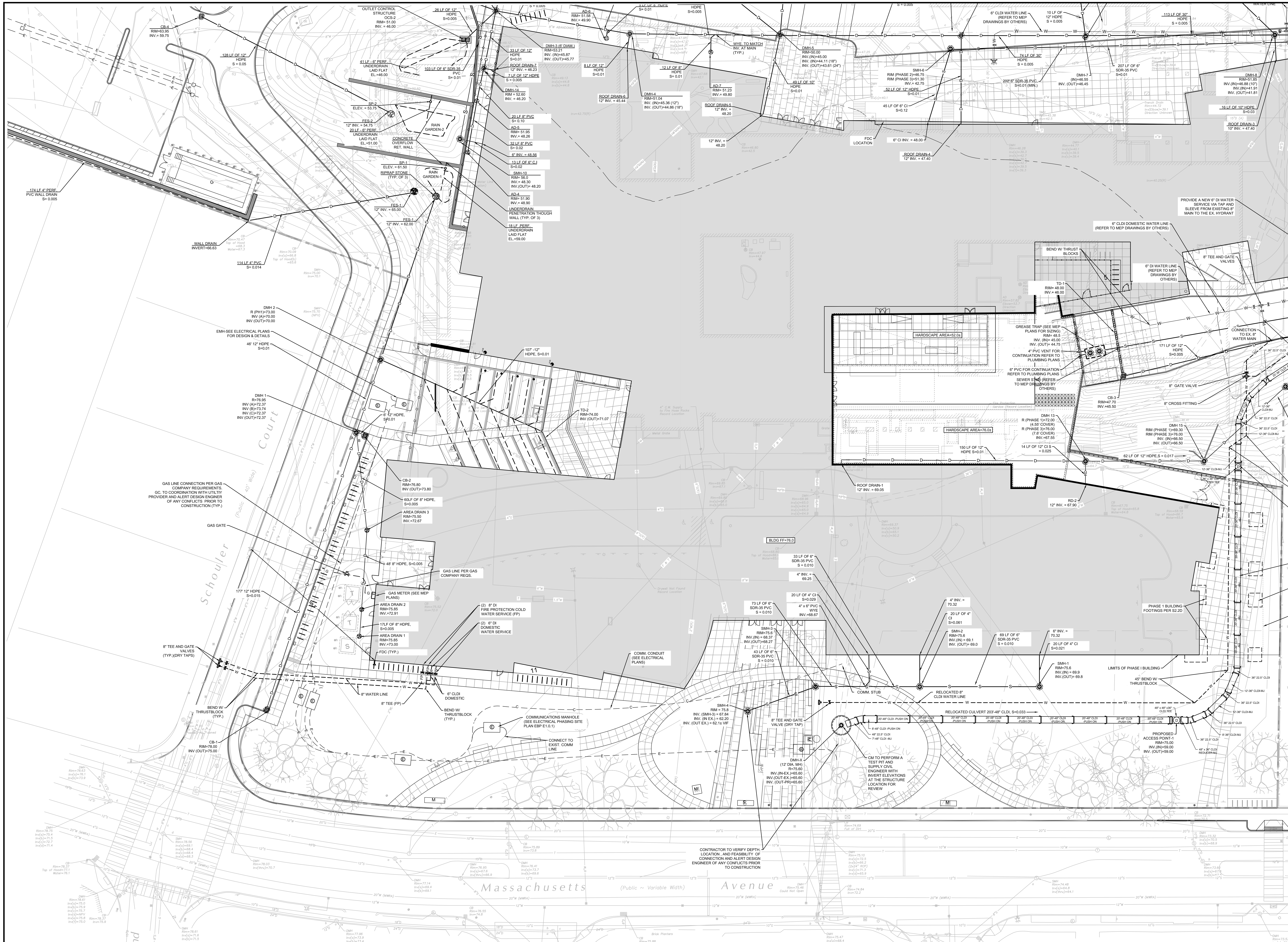


Arlington High School
Massachusetts Avenue, Arlington, Massachusetts
OVERALL UTILITY PLAN

SCALE: 1"=40' DRAWN BY: SM CHECKED BY: SG

REVISIONS NO	DATE	REMARKS	BY

DRAWING NUMBER
C-4.0
JOB NUMBER 17211



LEGEND:

D	PROPOSED STORM DRAINAGE LINE
RD	PROPOSED ROOF DRAIN LINE
W	PROPOSED WATER LINE
FP	PROPOSED DEDICATED FIRE PROTECTION LINE
S	PROPOSED SANITARY SEWER LINE
G	PROPOSED GAS LINE (BY OTHERS)
E	PROPOSED UNDERGROUND ELECTRIC LINE
SMH	PROPOSED SANITARY SEWER MANHOLE
DMH	PROPOSED STORM DRAINAGE MANHOLE
CB	PROPOSED CATCH BASIN
DCB	PROPOSED DOUBLE CATCH BASIN
	PROPOSED AREA DRAIN
CO	PROPOSED CLEANOUT
	PROPOSED HYDRANT
GV	PROPOSED GAS GATE VALVE
WV	PROPOSED WATER GATE VALVE
TSV	PROPOSED TAP AND SLEEVE VALVE
	PROPOSED TEE
	APPROX. LOCATION OF ENGINEERED SOIL BARRIER
	APPROX. LOCATION OF CONSTRUCTION FENCE
T	TRANSFORMER WITH BOLLARDS
S	SWITCH GEAR WITH BOLLARDS
E	COMMUNICATION MANHOLE
	PROPOSED FIRE DEPICTION CONNECTION SEE MEP PLANS

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CONSERVATION COMMISSION FILING SET
05-07-2020

20 10 0 20 40

KEYPLAN

a b c d e

Arlington High School
Massachusetts Avenue, Arlington, Massachusetts
UTILITY PLAN A

SCALE: 1"=20' DRAWN BY: SM CHECKED BY: SG

REVISIONS NO.	DATE	REMARKS	BY

DRAWING NUMBER
C-4.1
JOB NUMBER 17211

LEGEND:

D	PROPOSED STORM DRAINAGE LINE
RD	PROPOSED ROOF DRAIN LINE
W	PROPOSED WATER LINE
FP	PROPOSED DEDICATED FIRE PROTECTION LINE
S	PROPOSED SANITARY SEWER LINE
G	PROPOSED GAS LINE (BY OTHERS)
E	PROPOSED UNDERGROUND ELECTRIC LINE
SMH	PROPOSED SANITARY SEWER MANHOLE
DMH	PROPOSED STORM DRAINAGE MANHOLE
CB	PROPOSED CATCH BASIN
DCB	PROPOSED DOUBLE CATCH BASIN
	PROPOSED AREA DRAIN
CO	PROPOSED CLEANOUT
	PROPOSED HYDRANT
GV	PROPOSED GAS GATE VALVE
WV	PROPOSED WATER GATE VALVE
TSV	PROPOSED TAP AND SLEEVE VALVE
	PROPOSED TEE
	APPROX. LOCATION OF ENGINEERED SOIL BARRIER
	APPROX. LOCATION OF CONSTRUCTION FENCE
T	TRANSFORMER WITH BOLLARDS
S	SWITCH GEAR WITH BOLLARDS
©	COMMUNICATION MANHOLE
	PROPOSED FIRE DEPICTION CONNECTION SEE MEP PLANS

20 10 0 20 40
1 inch = 20 feet

COMMONWEALTH OF MASSACHUSETTS
STEPHEN R. GARVIN
No. 42772
REGISTERED PROFESSIONAL ENGINEER

KEYPLAN

a b c e d

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CONSERVATION COMMISSION FILING SET
05-07-2020

Arlington High School
Massachusetts Avenue, Arlington, Massachusetts
UTILITY PLAN B

SCALE: 1"=20' DRAWN BY: SM CHECKED BY: SG

DRAWING NUMBER
C-4.2

JOB NUMBER 17211

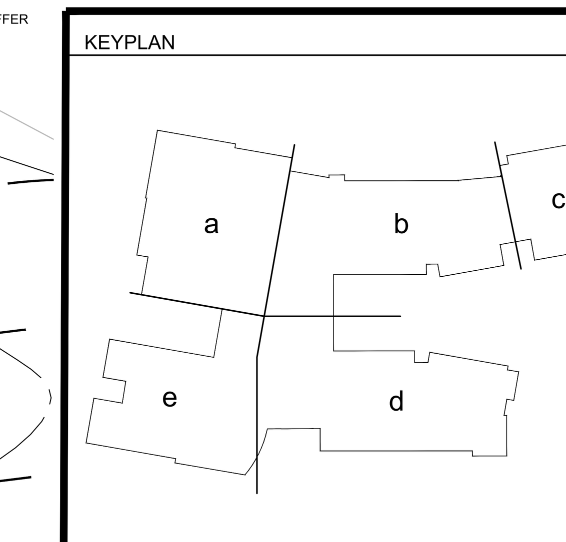
LEGEND:

D	PROPOSED STORM DRAINAGE LINE
RD	PROPOSED ROOF DRAIN LINE
W	PROPOSED WATER LINE
FP	PROPOSED DEDICATED FIRE PROTECTION LINE
S	PROPOSED SANITARY SEWER LINE
G	PROPOSED GAS LINE (BY OTHERS)
E	PROPOSED UNDERGROUND ELECTRIC LINE
SMH	PROPOSED SANITARY SEWER MANHOLE
DMH	PROPOSED STORM DRAINAGE MANHOLE
CB	PROPOSED CATCH BASIN
DCB	PROPOSED DOUBLE CATCH BASIN
	PROPOSED AREA DRAIN
CO	PROPOSED CLEANOUT
	PROPOSED HYDRANT
GV	PROPOSED GAS GATE VALVE
WV	PROPOSED WATER GATE VALVE
TSV	PROPOSED TAP AND SLEEVE VALVE
	PROPOSED TEE
	APPROX. LOCATION OF ENGINEERED SOIL BARRIER
	APPROX. LOCATION OF CONSTRUCTION FENCE
T	TRANSFORMER WITH BOLLARDS
S	SWITCH GEAR WITH BOLLARDS
E	COMMUNICATION MANHOLE
	PROPOSED FIRE DEPICTION CONNECTION SEE MEP PLANS

20 10 0 20 40

1 inch =20 feet

KEYPLAN



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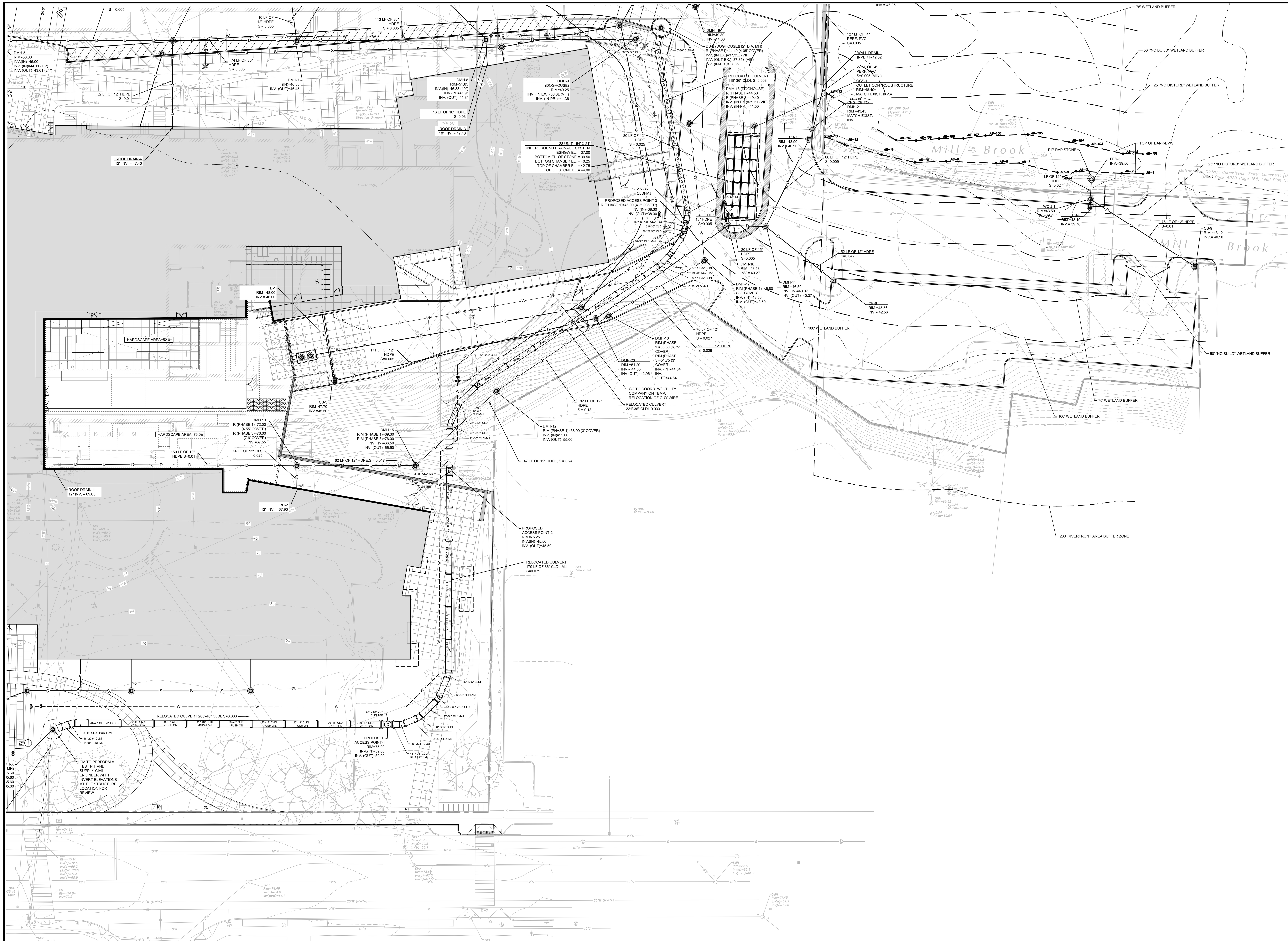
Arlington High School
Massachusetts Avenue, Arlington, Massachusetts
UTILITY PLAN C

SCALE: 1"=20' DRAWN BY: SM CHECKED BY: SG

DRAWING NUMBER
C-4.3

JOB NUMBER 17211



LEGEND:

D	PROPOSED STORM DRAINAGE LINE
RD	PROPOSED ROOF DRAIN LINE
W	PROPOSED WATER LINE
FP	PROPOSED DEDICATED FIRE PROTECTION LINE
S	PROPOSED SANITARY SEWER LINE
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DCB	PROPOSED DOUBLE CATCH BASIN
	PROPOSED AREA DRAIN
CO	PROPOSED CLEANOUT
	PROPOSED HYDRANT
GV	PROPOSED GAS GATE VALVE
WV	PROPOSED WATER GATE VALVE
TSV	PROPOSED TAP AND SLEEVE VALVE
	PROPOSED TEE
	APPROX. LOCATION OF ENGINEERED SOIL BARRIER
	APPROX. LOCATION OF CONSTRUCTION FENCE
T	TRANSFORMER WITH BOLLARDS
S	SWITCH GEAR WITH BOLLARDS
E	COMMUNICATION MANHOLE
	PROPOSED FIRE DEPICTION CONNECTION SEE MEP PLANS

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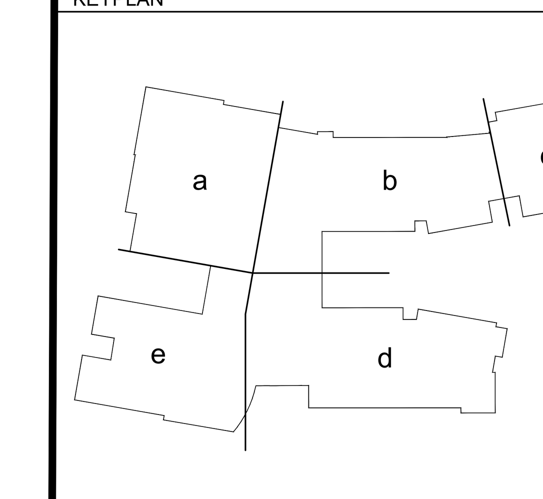
CONSERVATION COMMISSION FILING SET
05-07-2020

20 10 0 20 40
1 inch = 20 feet

COMMONWEALTH OF MASSACHUSETTS
STEPHEN R. GARVIN
No. 42172
REGISTERED PROFESSIONAL ENGINEER

KEYPLAN



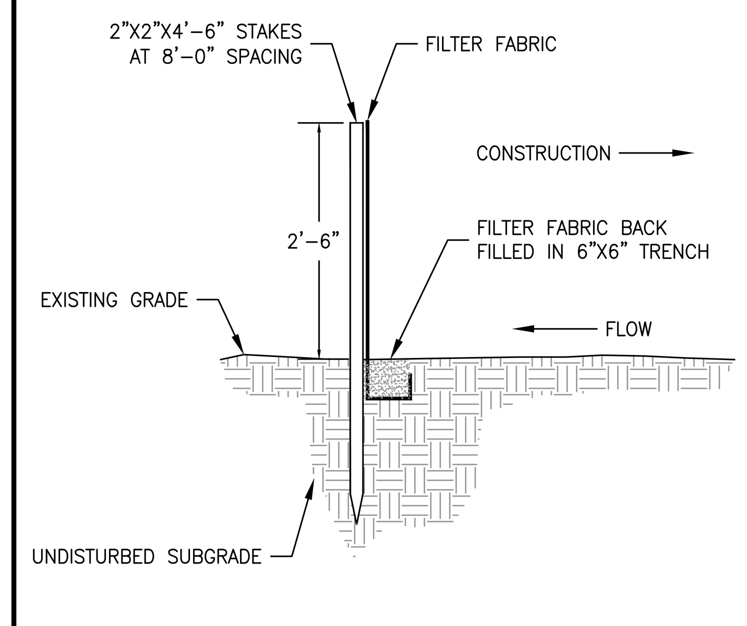
REVISIONS NO.	DATE	REMARKS	BY

Arlington High School
Massachusetts Avenue, Arlington, Massachusetts
UTILITY PLAN D

SCALE: 1"=20' DRAWN BY: SM CHECKED BY: SG

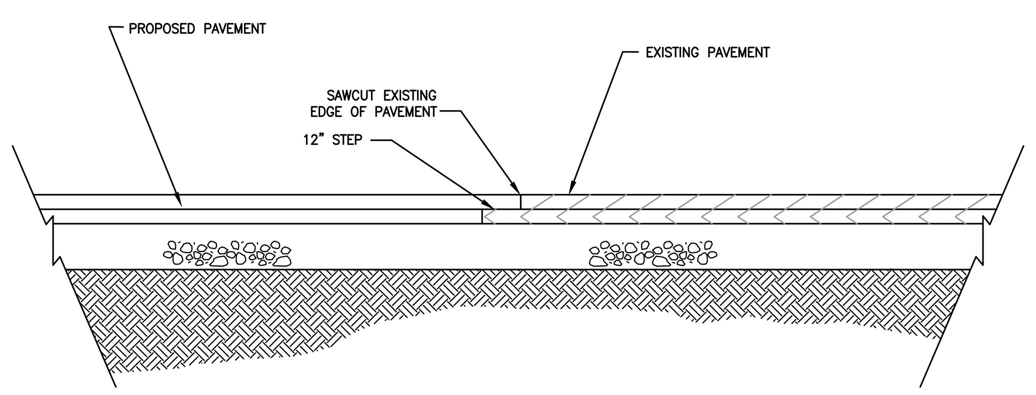
DRAWING NUMBER
C-4.4

JOB NUMBER 17211



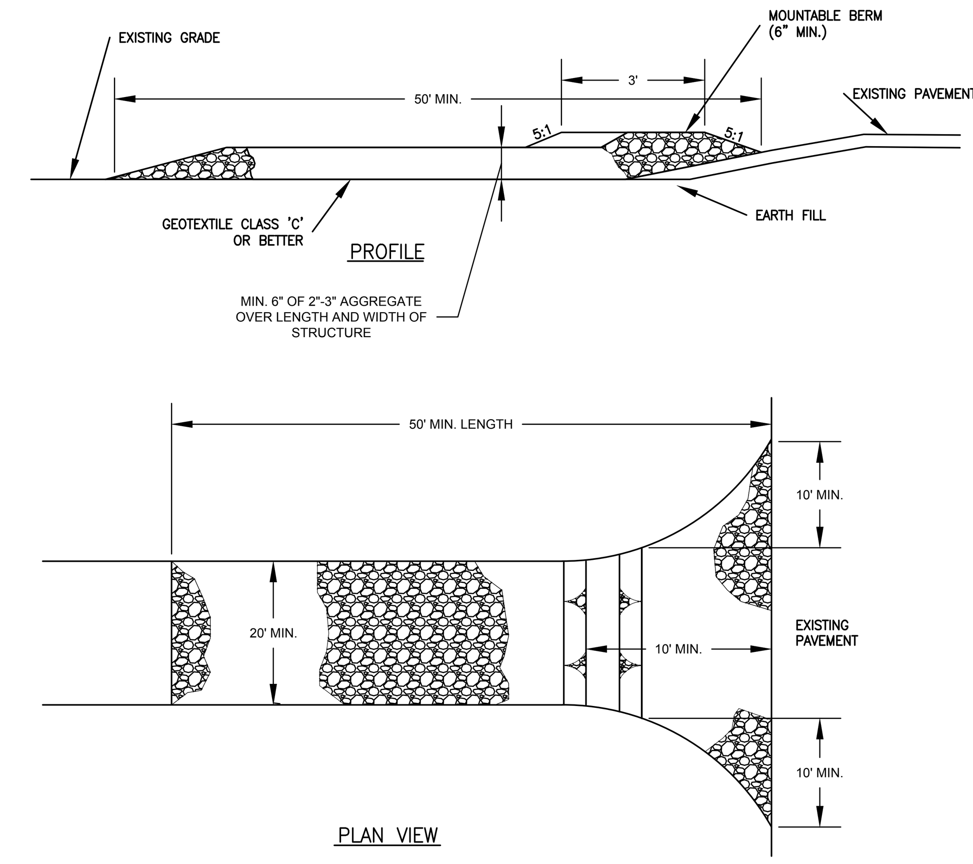
1 SILT FENCE

NTS



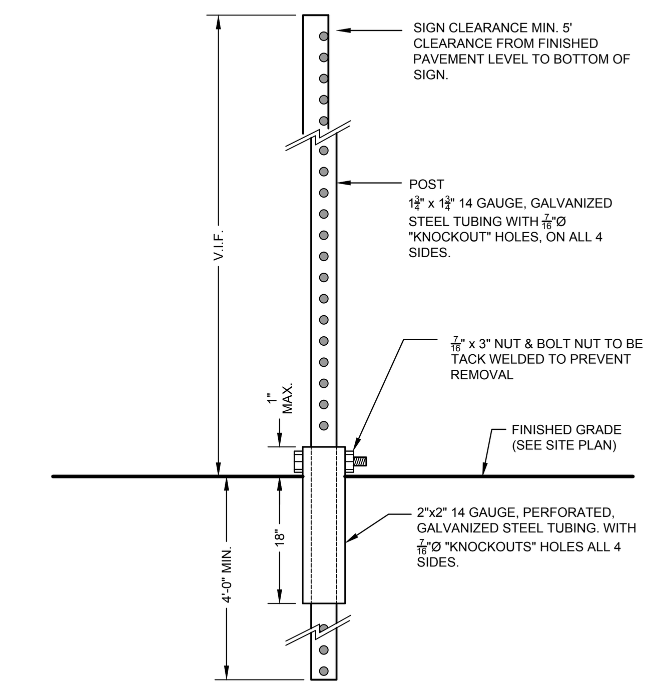
2 PAVEMENT KEY DETAIL

NTS



3 STABILIZED CONSTRUCTION ENTRANCE

NTS



4 TELESCOPING-BREAKAWAY TRAFFIC SIGN POST

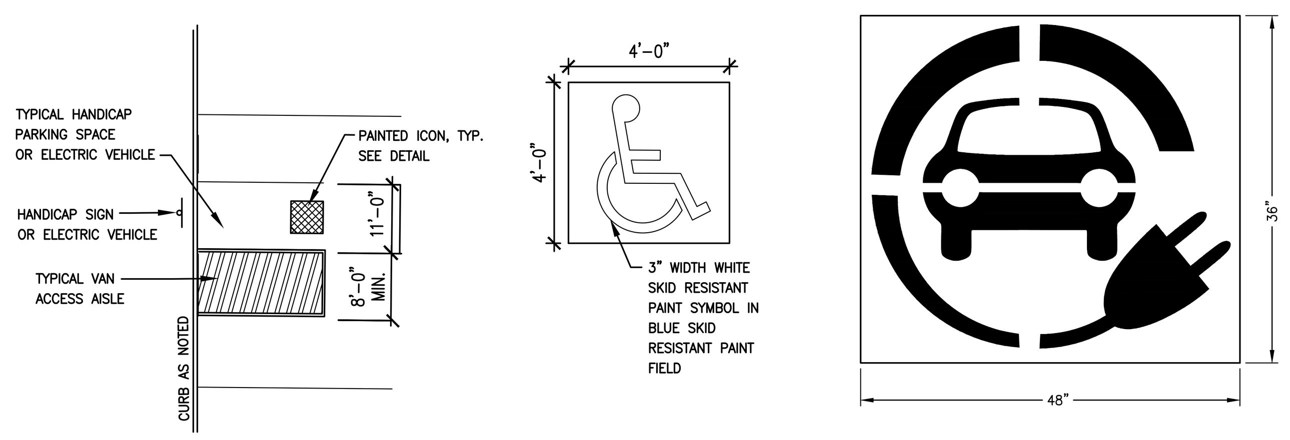
NTS

TRAFFIC CONTROL SIGNAGE SCHEDULE

				TEXT SEE MUTCD 2009 FOR TEXT DIMENSIONS AND COLORS		
R1-1	30"	30"	5.18	STOP	3	15.54
R7-8	12"	18"	1.50	RESERVED PARKING	3	4.50
R7-8P	18"	9"	1.13	VAN ACCESSIBLE	1	1.13
R5-1	30"	30"	6.25	DO NOT ENTER	1	6.25
W11A-2	30"	30"	3.13		1	3.13
W16-7P	24"	12"	2.00		1	2.00

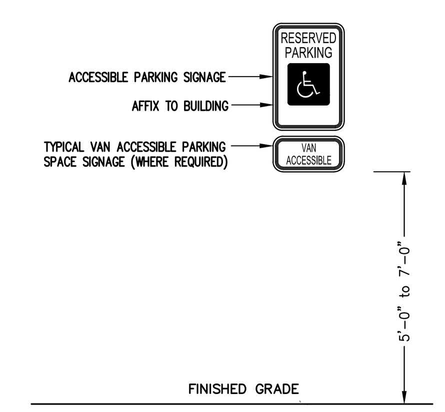
5 SIGNAGE CHART

NTS



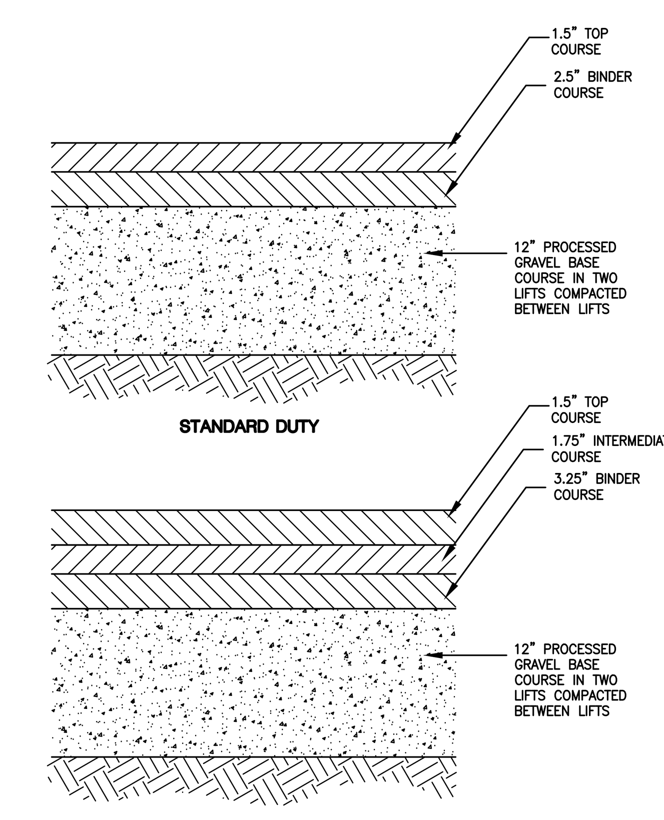
6 PAVEMENT MARKING DETAIL

NTS



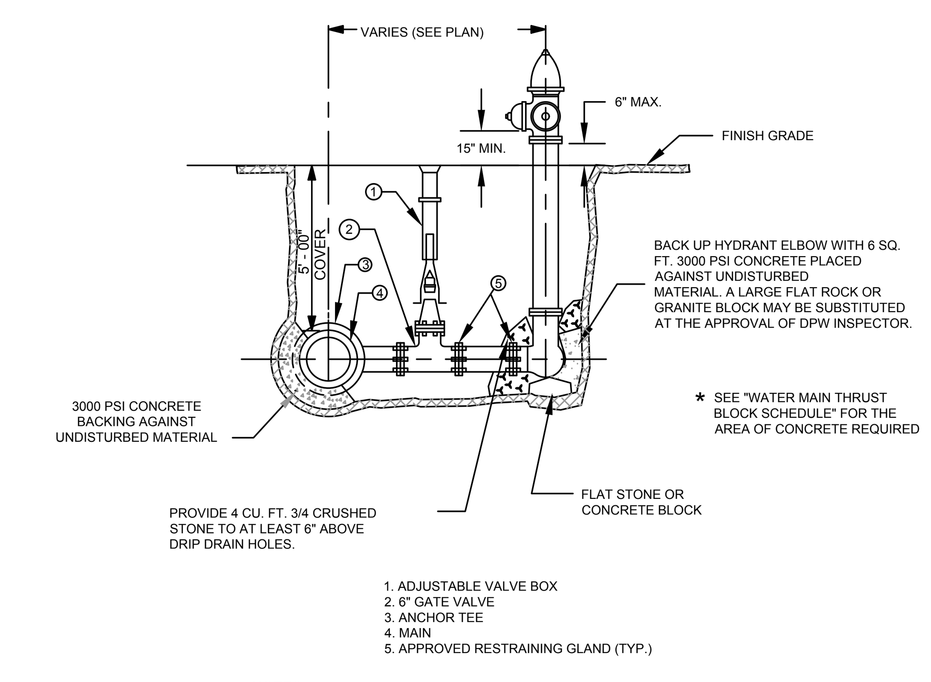
7 GROUND MOUNTED SIGNAGE

NTS

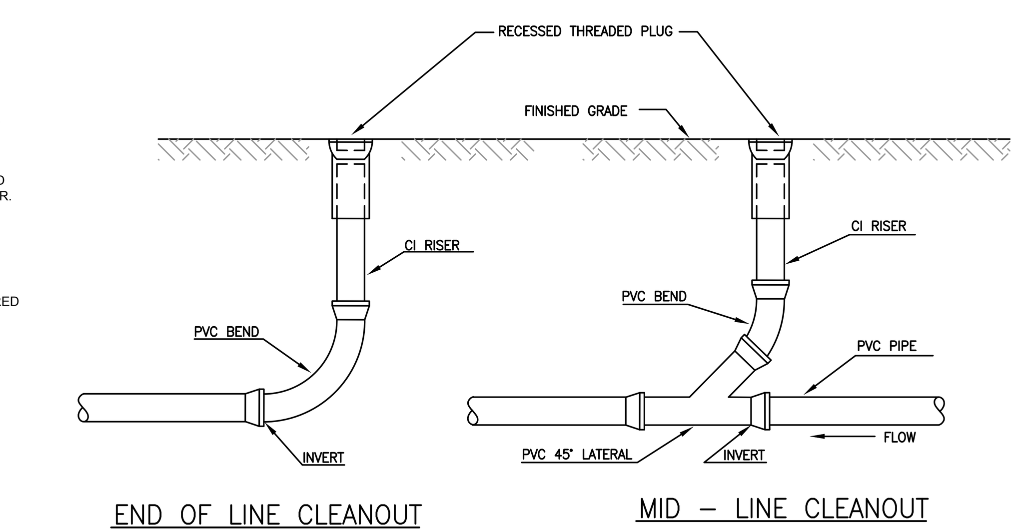


8 BITUMINOUS PAVEMENT

NTS

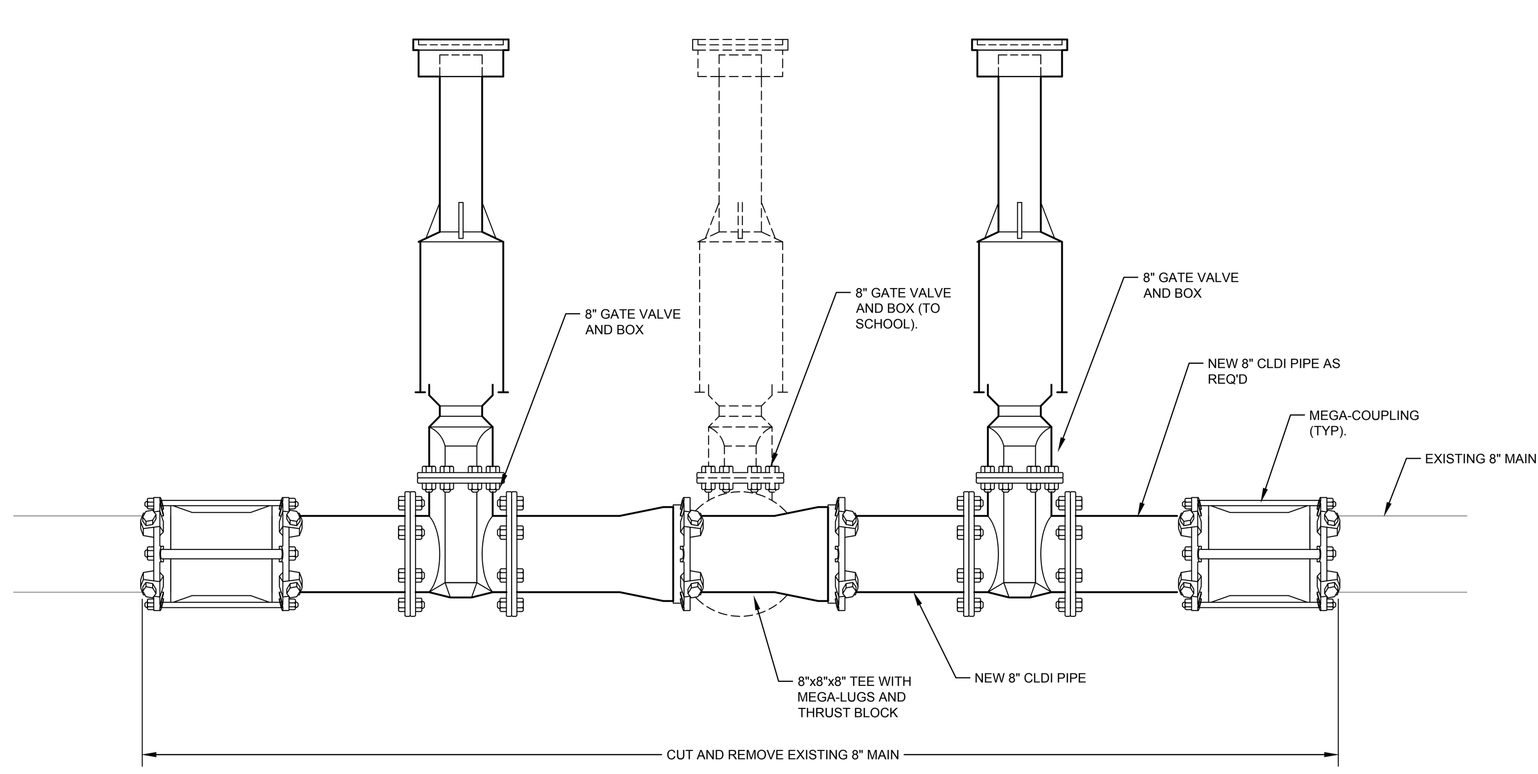


9 HYDRANT DETAIL



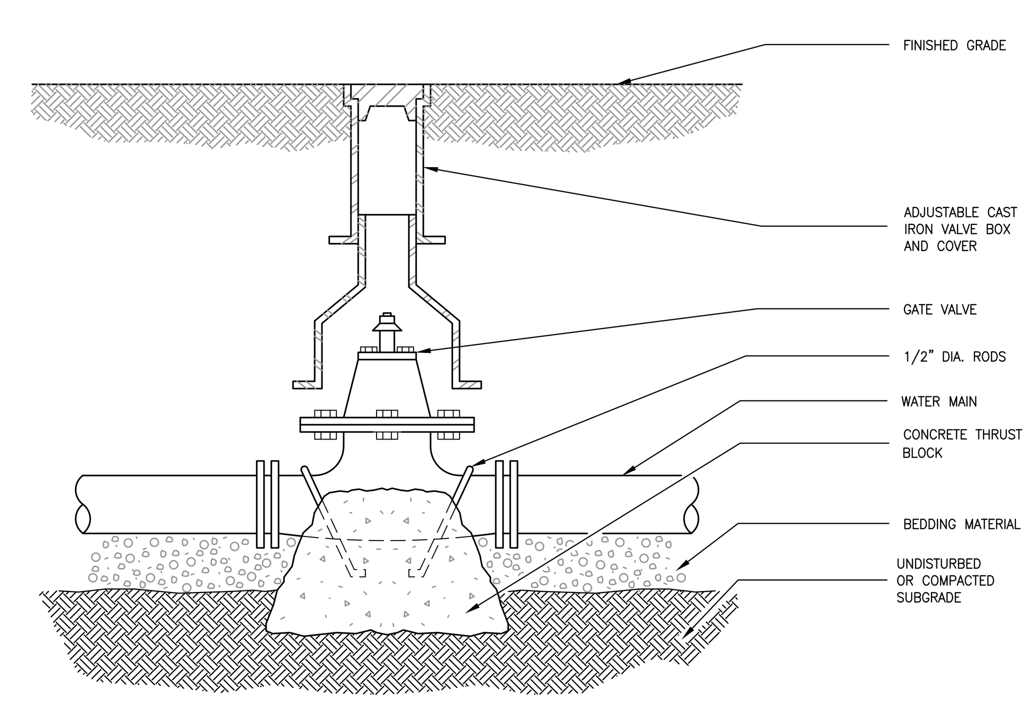
10 CLEANOUT

NTS



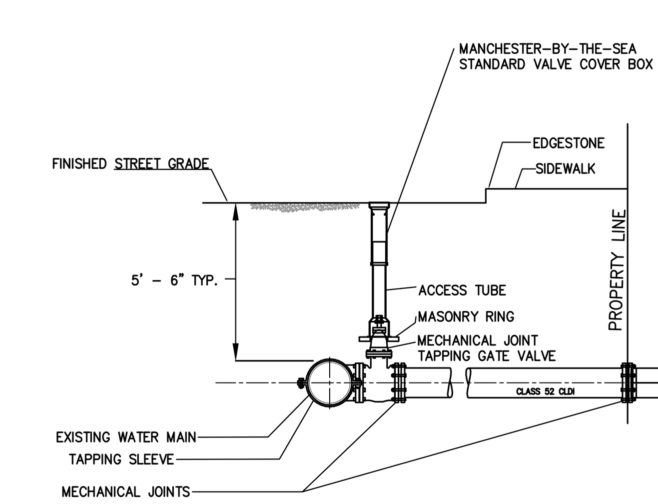
11 WATER MAIN CUT IN DETAIL (SECTION)

NTS



12 GATE VALVE AND BOX

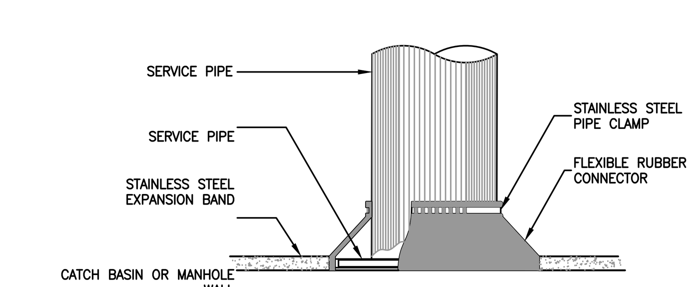
NTS



NOTES: CONCRETE THRUST BLOCK TO BE USED ONLY WHERE IT WILL BEAR ON UNDISTURBED EARTH. USE RESTRAINED JOINT FITTING (MEGALUG OR APPROVED EQUAL) WHERE CONCRETE THTUST BLOCK IS UNACCEPTABLE. SIZE OF BLOCK OR MEGALUG TO BE DESIGNED FOR SPECIFIC CONDITIONS.

13 TAPPING SLEEVE AND GRATE VALVE 6"/8"

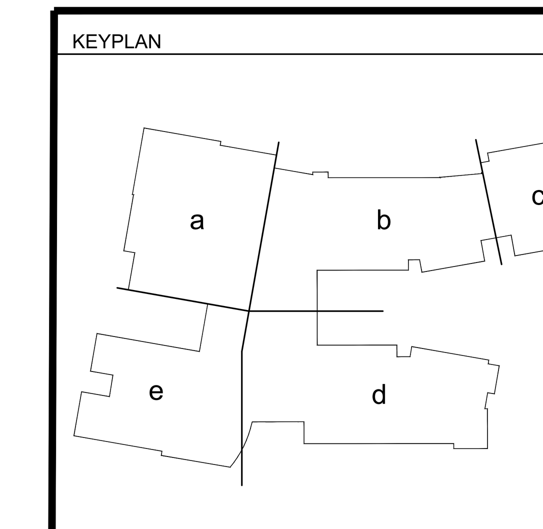
NTS



NOTES:
1. OPENING IN CONCRETE WALL SHALL BE CORED USING HIGH SPEED DIAMOND DRILL.
2. ALL METAL FIXTURES SHALL BE OF STAINLESS STEEL.
3. SERVICE LINE SHALL BE FLUSH WITH THE INSIDE OF THE CONCRETE WALL.

14 PIPE CONNECTION TO MANHOLE

KEYPLAN



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Civil Engineers + Land Surveyors

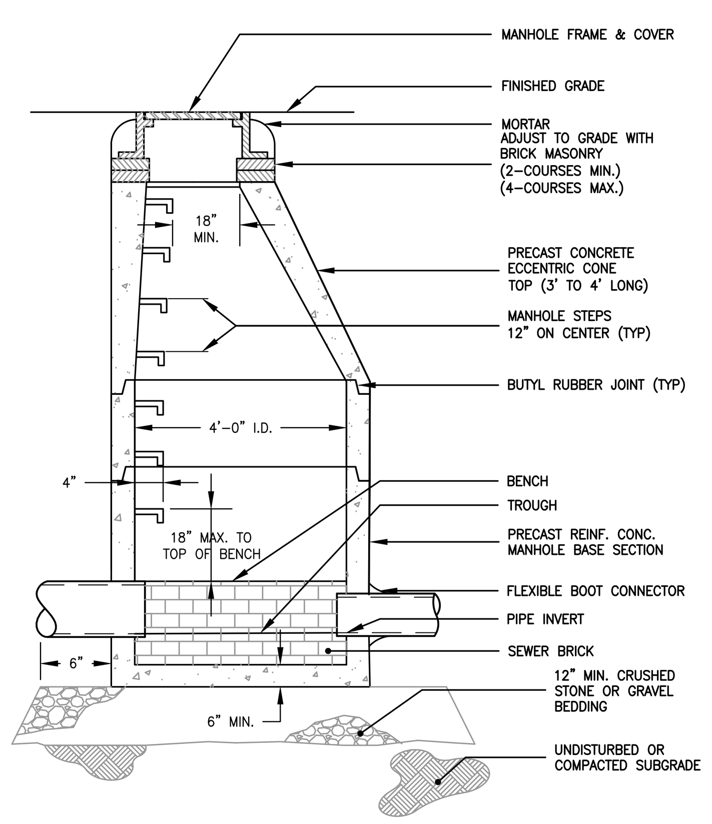
CONSERVATION COMMISSION FILING SET
05-07-2020

Arlington High School
Massachusetts Avenue, Arlington, Massachusetts
DETAILS SHEET

SCALE: NTS DRAWN BY: SM CHECKED BY: SG

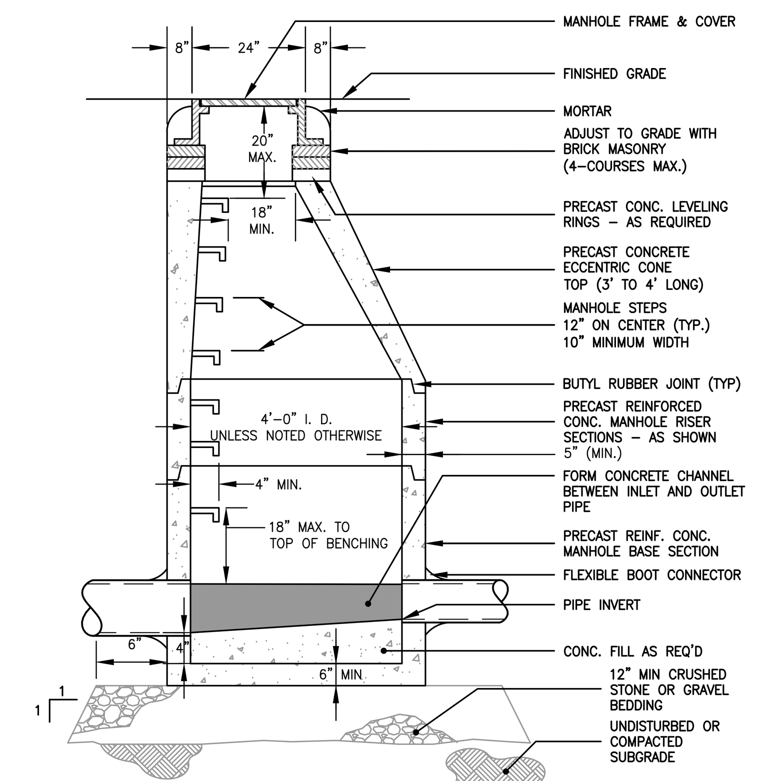
DRAWING NUMBER
C-5.0

JOB NUMBER 17211



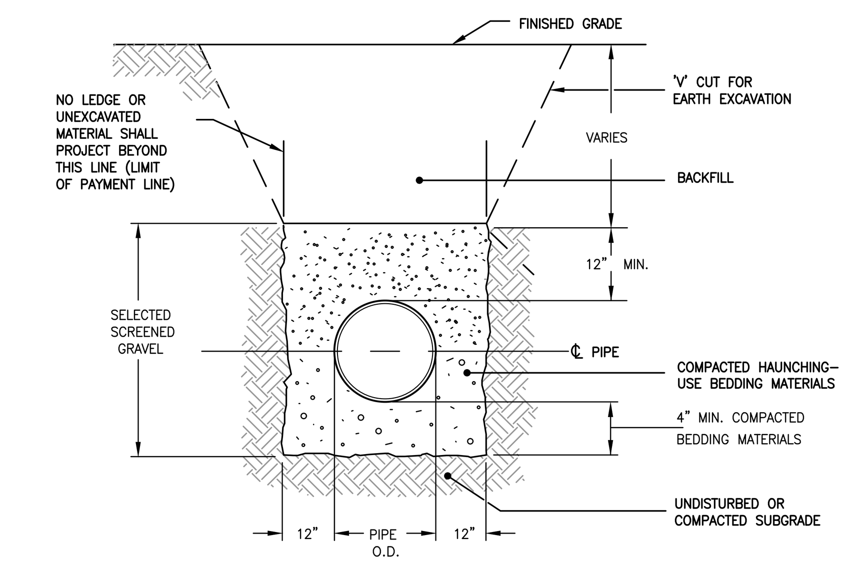
1 PRECAST SANITARY MANHOLE

NTS



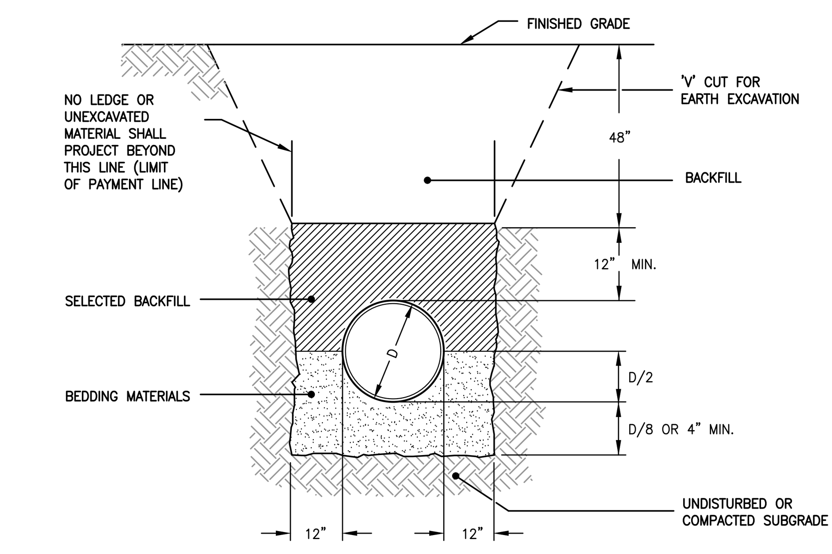
2 PRECAST STORM DRAIN MANHOLE

NTS



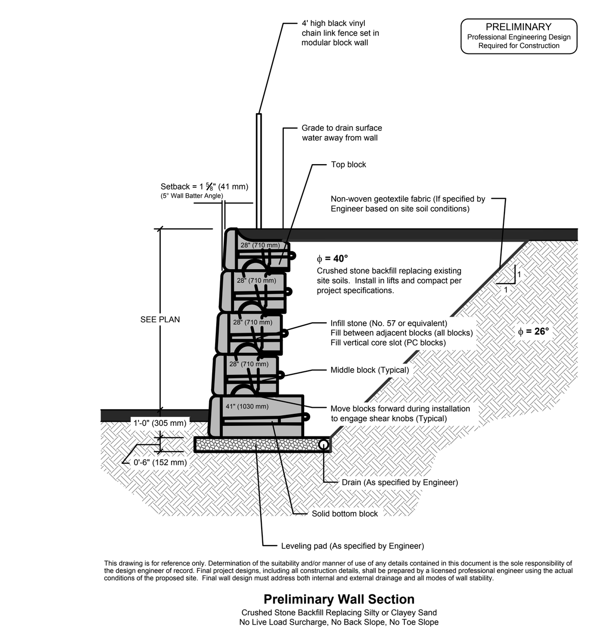
3 TRENCH SECTION- HDPE/PVC/CI GRAVITY PIPE

NTS



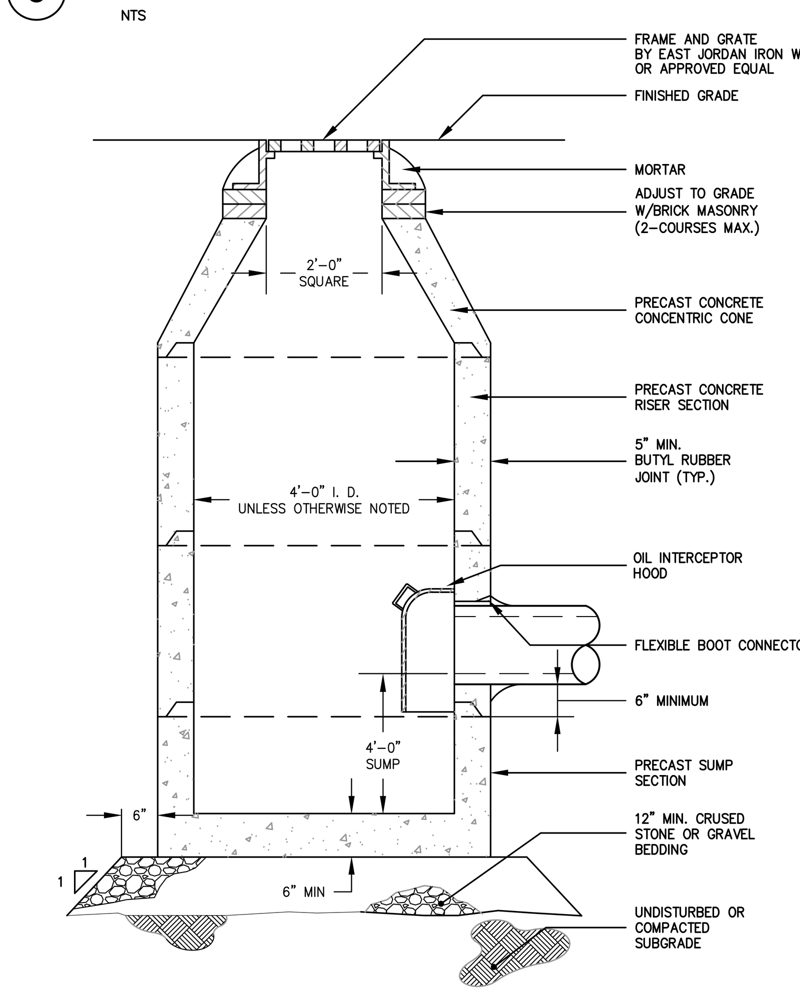
4 TRENCH SECTION - C.L.D.I. WATER PIPE

NTS



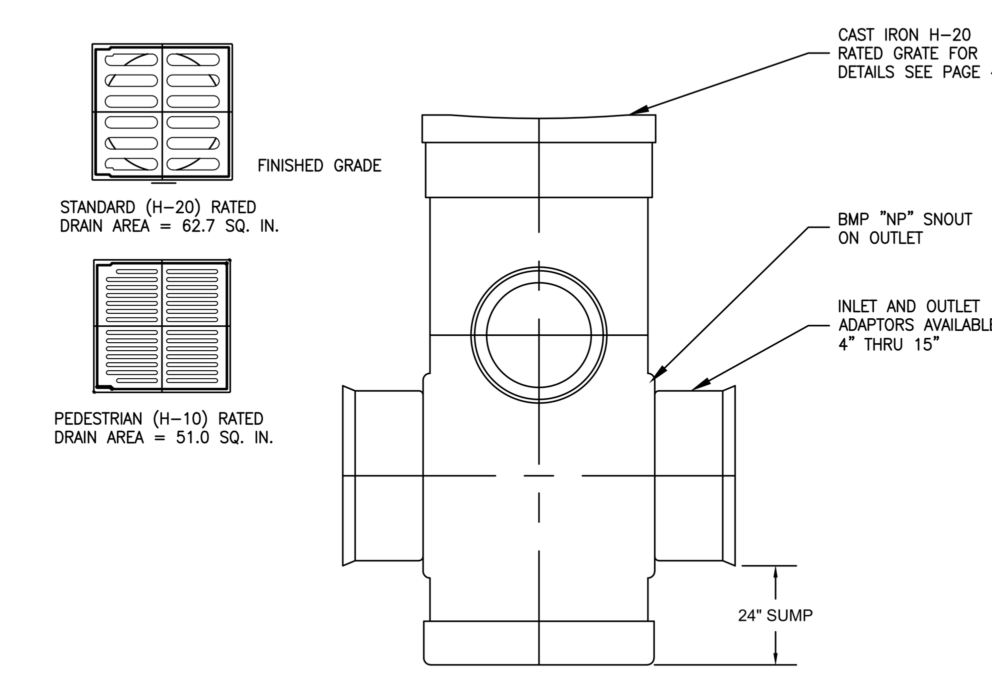
5 MODULAR BLOCK RETAINING WALL

NTS

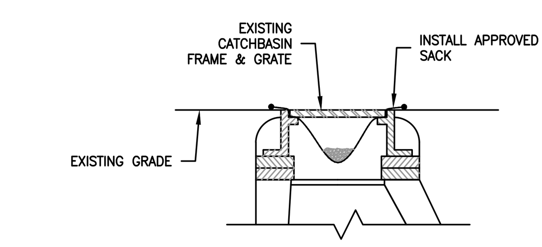


NTS

6 CATCH BASIN

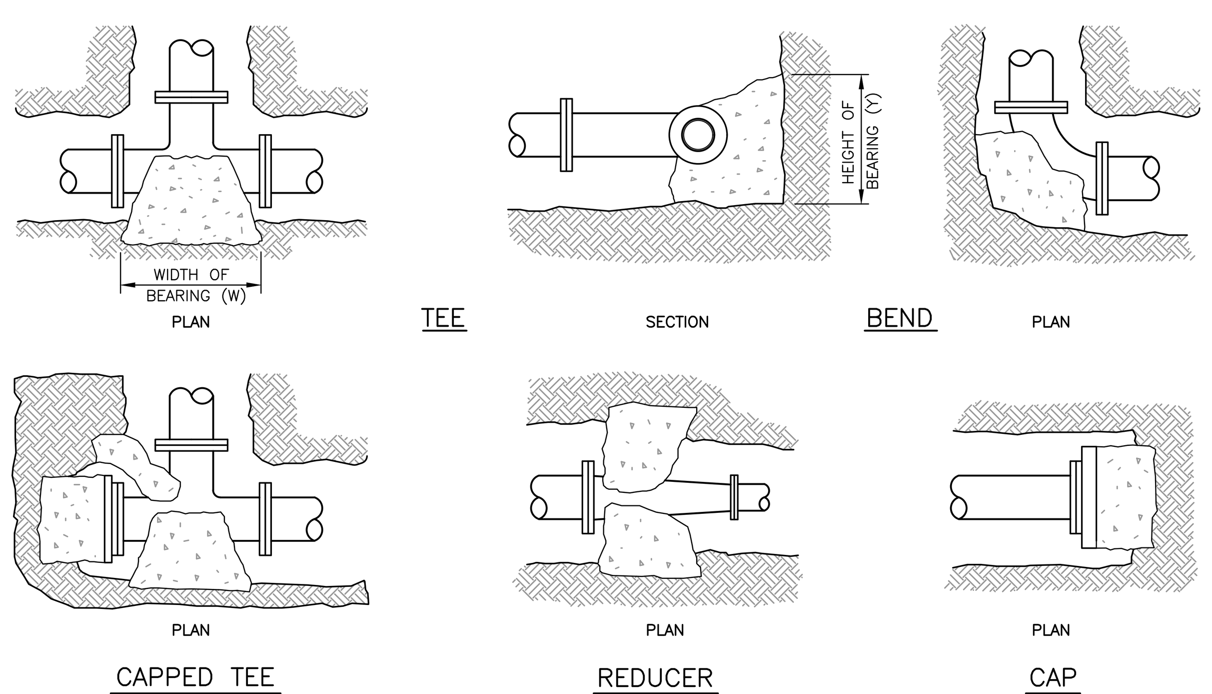


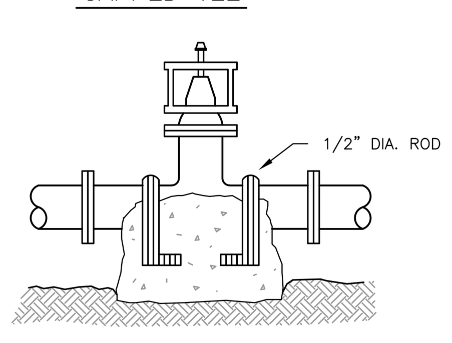
7 AREA DRAIN



8 CATCHBASIN W/ SILT SACK

NTS



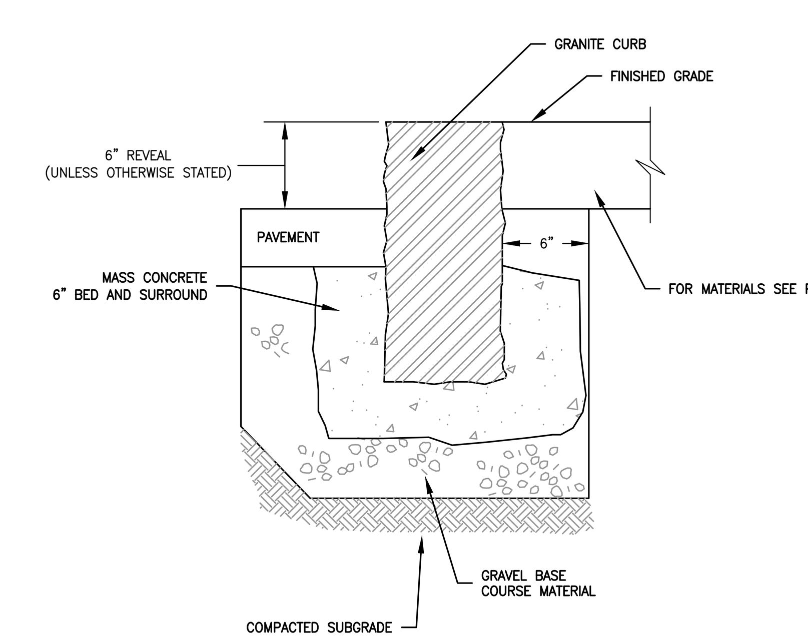


MINIMUM THRUST BLOCK AREA REQUIRED (Y x W)		
PIPE SIZE	WATER PIPE	
	TEE, DEAD END, 90° BEND	45° & 22~8° BENDS
4" OR LESS	3 SQ. FEET	3 SQ. FEET
6"	4 SQ. FEET	3 SQ. FEET
8"	6 SQ. FEET	3 SQ. FEET
10"	9 SQ. FEET	5 SQ. FEET
12"	13 SQ. FEET	7 SQ. FEET
16"	23 SQ. FEET	12 SQ. FEET

1. THRUST BLOCKS TO EXTEND TO UNDISTURBED GROUND.
2. ALL CONCRETE SHALL BE CLASS B.
3. TABLE IS BASED ON 3000 LB./SQ. FT. SOIL. IF SOIL CONDITIONS ARE FOUND TO INDICATE SOIL BEARING LESS, THE AREAS SHALL BE INCREASED ACCORDINGLY.
4. AREAS FOR PIPES GREATER THAN 16" SHALL BE CALCULATED FOR EACH PROJECT.
5. FOR ALL NON BEARING VERTICAL SURFACES.

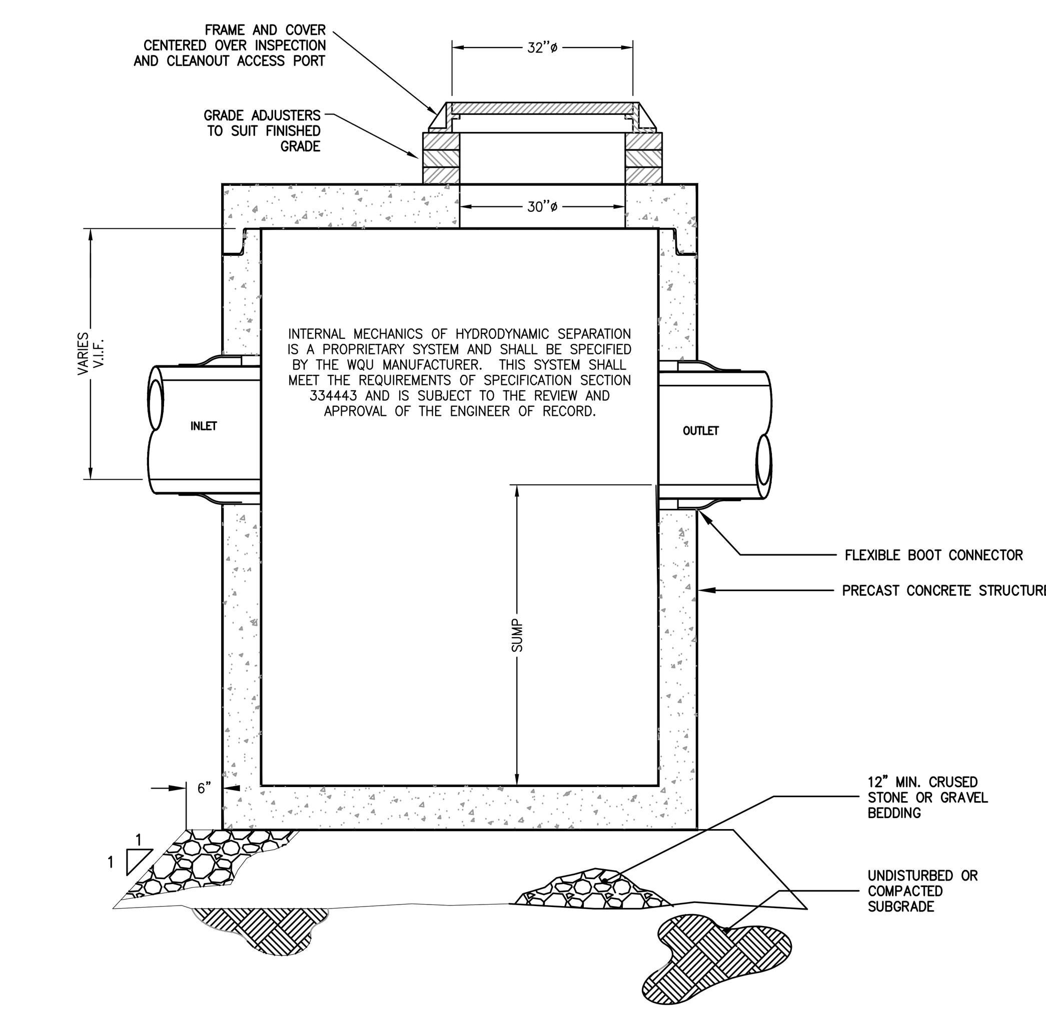
9 THRUST BLOCKS (WATER SYSTEM)

NTS



9 VERTICAL GRANITE CURB

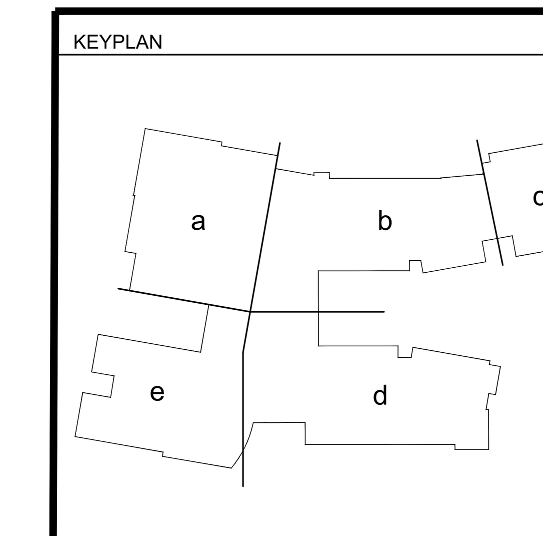
NTS



10 WATER QUALITY UNIT

NTS

KEYPLAN



REVISIONS NO.	DATE	REMARKS	BY

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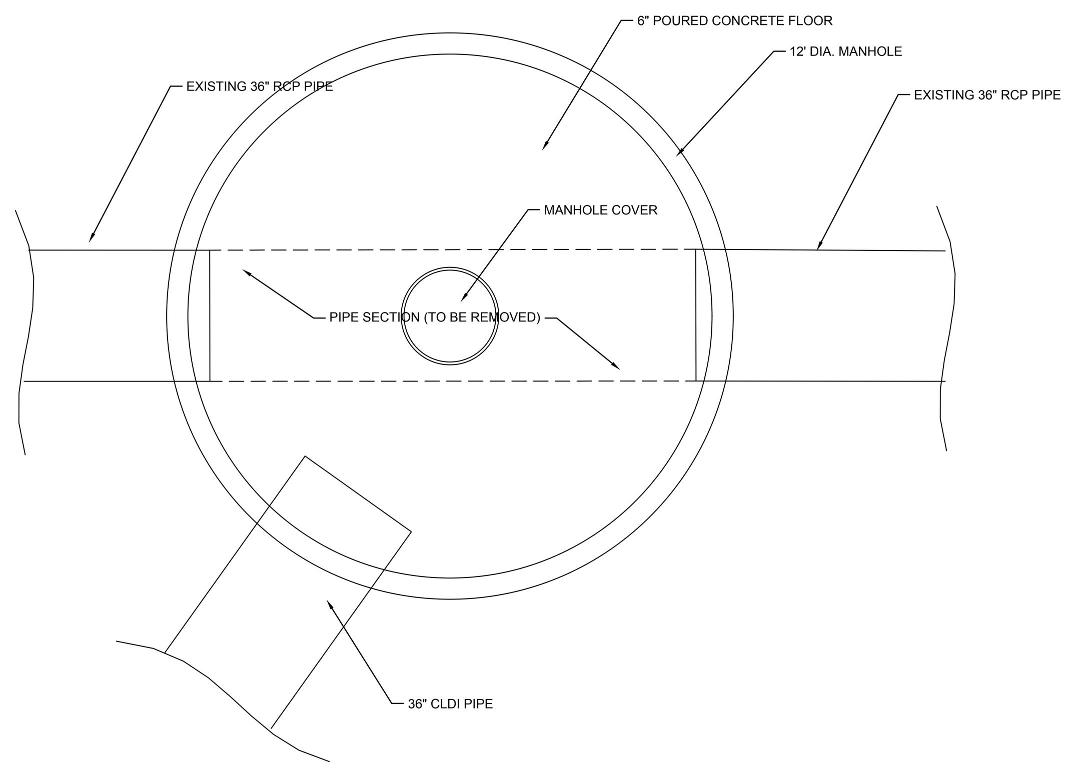
CONSERVATION COMMISSION FILING SET
05-07-2020

Arlington High School
Massachusetts Avenue, Arlington, Massachusetts
DETAILS SHEET

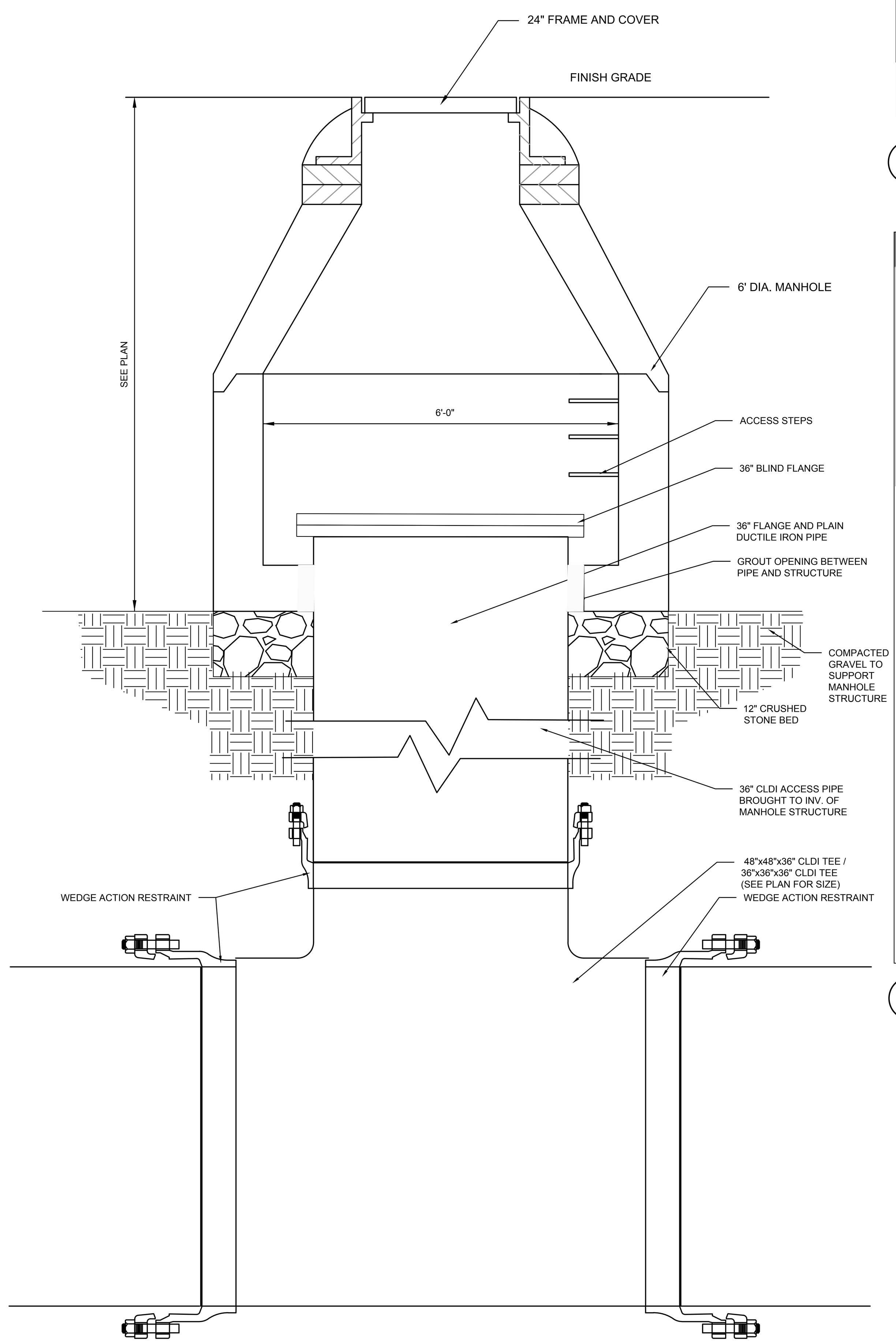
SCALE: NTS DRAWN BY: SM CHECKED BY: SG

DRAWING NUMBER
C-5.1

JOB NUMBER 17211



1 SPECIAL "DOG HOUSE" STRUCTURE



2 CLDI ACCESS POINT-48"

BLIND FLANGES

Blind Flange Solid

Blind Flange Tapped

C153 Mechanical Joint Compact Fittings

11-1/4 Degree Bends

MJ x MJ 11¼° DMB

MJ x PE 11¼° DME

C153 Mechanical Joint Compact Fittings

DMR SPR LPR PPR

Reducers

C153 Mechanical Joint Compact Fittings

3-48" Ductile Iron Mechanical Joint Fittings Class 350

MATERIAL: Ductile Iron ASTM A536

PRESSURE: 350PSI WATER WORKING PRESSURE (CLASS 350) 3" - 24": & 250 PSI 30" - 48"

TESTING: In accordance with ANSI / AWWA C153 / A21.53 & UL - FM requirements

LAYING LENGTH:Short body design - straight section of body deleted to provide a compact and lighter fitting without reducing strength or flow characterisitics, in accordance with ANSI / AWWA C153 / A21.53

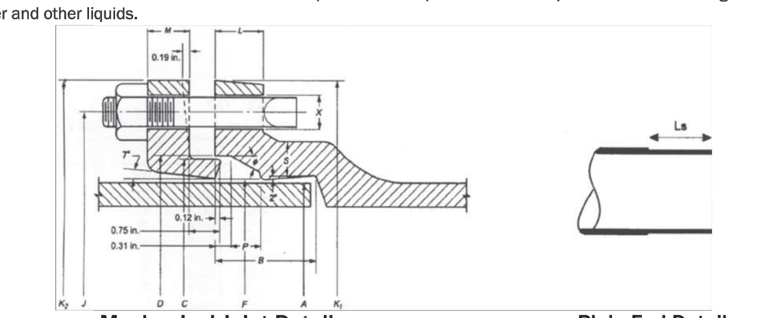
CEMENT LINING: In accordance with ANSI / AWWA C104 / A21.4 COATING: Tar coated (bituminous) inside and out in accordance with ANSI / AWWA C104 / A21.4

GASKETS: SBR in accordance with ANSI / AWWA C111 / A21.11

T-BOLTS: Low Alloy corrosion resistant high strength steel in accordance with ANSI / AWWA C111 / A21.11

APPROVALS: 3"-16" Underwriters Laboratories listed and Factory Mutual Approved.

STANDARDS: Certified to NSF61 Standard ANSI / AWWA C153 / A21.53 for Compact Ductile Iron Fittings 3"-48" for water and other liquids.



Mechanical Joint Detail

Plain End Detail

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C153 Mechanical Joint Compact Fittings

90 Degree Bends

MJ x MJ 90° DMB

MJ x PE 90° DME

45 Degree Bends

MJ x MJ 45° DMB

MJ x PE 45° DME

22-1/2 Degree Bends

MJ x MJ 22½° DMB

MJ x PE 22½° DME

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C153 Mechanical Joint Compact Fittings

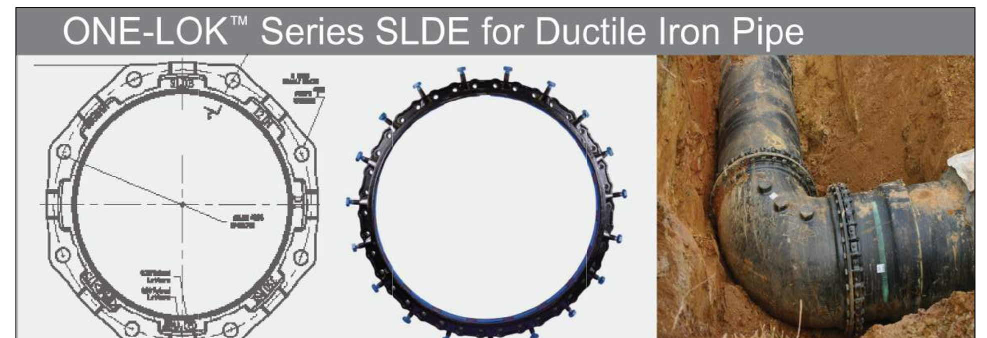
Tees (continued)

MJ x MJ DMT

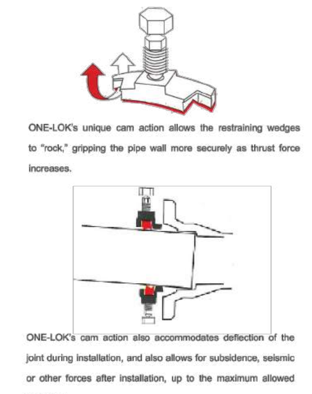
MJ x FLANGE DMF

3 CLDI MJ FITTINGS

ONE-LOK™ Series SLDE for Ductile Iron Pipe



Features & Advantages:



ONE-LOK's unique cam action allows the restraining wedges to "rock," gripping the pipe wall more securely as thrust force increases.

ONE-LOK's cam action also accommodates deflection of the joint during installation, and also allows for subsidence, seismic or other forces after installation, up to the maximum allowed deflection.

1) The SIGMA ONE-LOK Series SLDE is a mechanical joint restraining gland that implements a series of individually activated wedges into the mechanical joint follower gland. When the wedge segment is engaged by the actuating bolt, the primary contact edges of each wedge segment lock onto the pipe wall. This action causes the primary contact edges to grip the pipe and effectively restrain all classifications of ductile iron pipe.

2) ONE-LOK SLDE's precision contoured wedges provide proper contact and support of the ductile iron pipe wall. Each wedge is manufactured with an elongated contour that evenly matches the outside circumference of each nominal diameter of ductile iron pipe. This elongated contour also eliminates the concern of damage to both the pipe wall and the interior cement mortar lining caused by point loading, even on the thinner pressure classes of ductile iron pipe.

3) ONE-LOK SLDE's wedge actuating bolt provides the installer with a visual torque indicator. The breakaway top ensures proper engagement of the wedge segment at the time of installation. Unlike other actuating bolts, the ONE-LOK SLDE is manufactured with a proprietary quality control system that ensures the breakaway tops will activate at the correct torque. The breakaway top is sized to match the same dimensions of the bolts and nuts used to assemble the mechanical joint fitting and follower gland, eliminating the need for special installation tools. Once engaged, the actuating bolt leaves a residual hex-head shank, allowing post-installation disassembly of the restrained joint, if necessary.

4) ONE-LOK SLDE's unique wedge segment and actuating bolt design allows the two components to interface using a cam action principle, allowing the wedge segments to rock and increase their grip on the pipe wall as thrust on the assembled joint increases. This also allows improved resistance to subsidence, seismic forces, and other movement within the maximum deflection limitations of the mechanical joint under applicable AWWA standards.

Deflection Chart

Nominal Size	Item #	Deflection
3-12"	SLDE3-SLDE12	5 deg
14-16"	SLDE14-SLDE16	2 deg
18-30"	SLDE18-SLDE30	1.5 deg
36-64"	SLDE36-SLDE64	1 deg

Sample Specification:

Restraint for standard mechanical joint fittings shall be incorporated in the design of the follower gland and shall utilize multiple wedge segments that act against the pipe, increasing their resistance as the line pressure increases. The assembled joint shall maintain the maximum flexibility and deflection of all nominal pipe sizes after burial. Restraining gland, wedge segments, and actuating bolts shall be manufactured of high strength ductile iron conforming to the requirements of ASTM A536, Grade 65-45-12. Wedge segments shall be heat treated to a hardness of 370 BHN minimum. Dimensions shall be compatible with standardized mechanical joints conforming to the requirements AWWA C111/ANSI A21.11 and AWWA C153/ANSI 21.53 through 24" (latest revision). Breakaway tops shall be incorporated in the design of the actuating bolts to visually ensure proper torque. The manufacturing of the actuating bolt must incorporate a quality control procedure that is deemed acceptable by the specifier and positively assures precise and consistent operating torque of the breakaway top. The mechanical joint restraining devices shall have a working pressure rating of 350psi (for sizes 3-16") and 250 psi (for sizes 18-64") minimum and provide no less than a safety factor of 2:1. Restraint shall be UL Listed and FM approved in applicable sizes. Restraining device shall be SIGMA ONE-LOK™ or approved equal.

Materials:

- Gland body, brackets, wedge segments & actuating bolts: ASTM A536 65-45-12 ductile iron.
- Wedge segments are heat treated to a minimum hardness of 370BHN
- T-head bolts & nuts: High strength, low alloy steel meeting AWWA/ANSI C111/A21.11 with minimum 65,000psi tensile strength and 45,000psi yield strength.

Dimensions in Inches, Weights in Pounds

4 CLDI MJ WEDGE ACTION RESTRAINTS

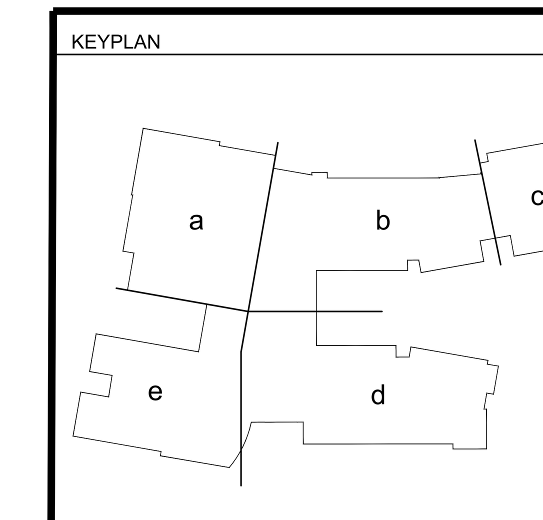
DUCTILE FLANGED PIPE ANSI/AWWA C115/A21.15

SIZE IN.	PRESSURE RATING PSI	NORMINAL WALL THICKNESS IN. CLASS 53	PIPE OD IN.	MINIMUM LENGTH IN.	MAXIMUM LENGTH IN.	WEIGHT IN POUNDS		
						PER FOOT PLAIN END	ONE FLANGE	FULL LENGTH WITH TWO FLANGES
3"	250	.31	3.96	4 1/2	17'-6"	10.9	7	230
4"	250	.32	4.80	4 1/2	19'-6"	13.8	13	295
6"	250	.34	6.90	4 1/2	19'-6"	21.4	17	450
8"	250	.36	9.05	4 1/2	19'-6"	30.1	27	640
10"	250	.38	11.10	6	19'-6"	39.2	38	840
12"	250	.40	13.20	6	19'-6"	49.2	59	1080
14"	250	.42	15.30	7	19'-6"	60.1	70	1310
16"	250	.43	17.40	7	19'-6"	70.1	88	1545
18"	250	.44	19.50	7	19'-6"	80.6	90	1750
20"	250	.45	21.60	7	19'-6"	91.5	112	2010
24"	250	.47	25.80	8	19'-6"	114.4	155	2540
30"	250	.51	32.00	12	19'-6"	154.4	245	3500
36"	250	.58	38.30	14	19'-6"	210.3	354	4810
42"	250	.65	44.50	18	19'-6"	274.0	512	6370
48"	250	.72	50.80	18	19'-6"	346.6	632	8020
54"	250	.81	57.56	20	19'-6"	441.9	716	10050
60"	250	.83	61.61	20	19'-6"	485	1113	11680
64"	250	.87	65.67	21	19'-0"	542.0	1824	13950

36" Flange x Plain End DI Pipe, Length to suit field requirements. 19'6" max total length.

5 CLDI PIPE

KEYPLAN



REVISIONS NO.	DATE	REMARKS	BY

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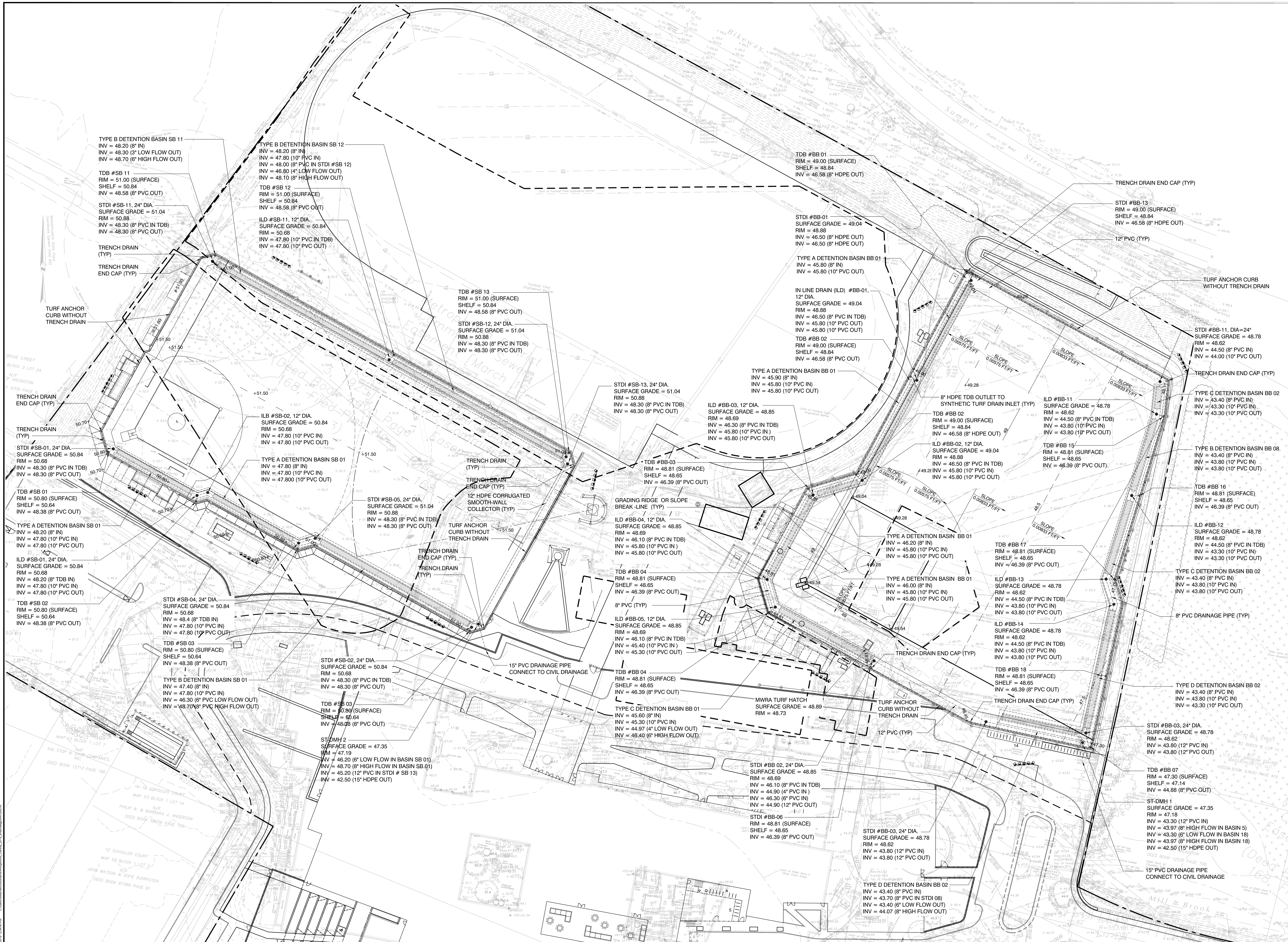
CONSERVATION COMMISSION FILING SET
05-07-2020

Arlington High School
Massachusetts Avenue, Arlington, Massachusetts
DETAILS SHEET

SCALE: NTS DRAWN BY: SM CHECKED BY: SG

DRAWING NUMBER
C-5.2
JOB NUMBER 17211



HMFH
HMFH ARCHITECTS

JJA SPORTS, LLC

CONSERVATION FILING SET
05-07-2020

KEYPLAN

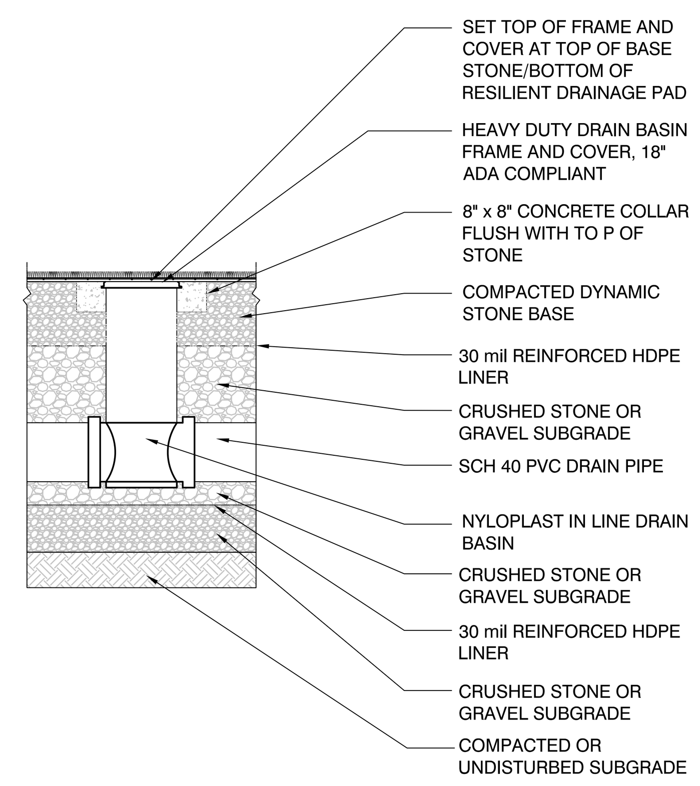
REVISIONS NO.	DATE	REMARKS	BY

Arlington High School
Massachusetts Avenue, Arlington, Massachusetts
Outdoor Athletic Improvements
Grading and Drainage Plan
SCALE: 1" = 30' DRAWN BY: J AMATO CHECKED BY: J AMATO

DRAWING NUMBER
L8.3

NOTES:

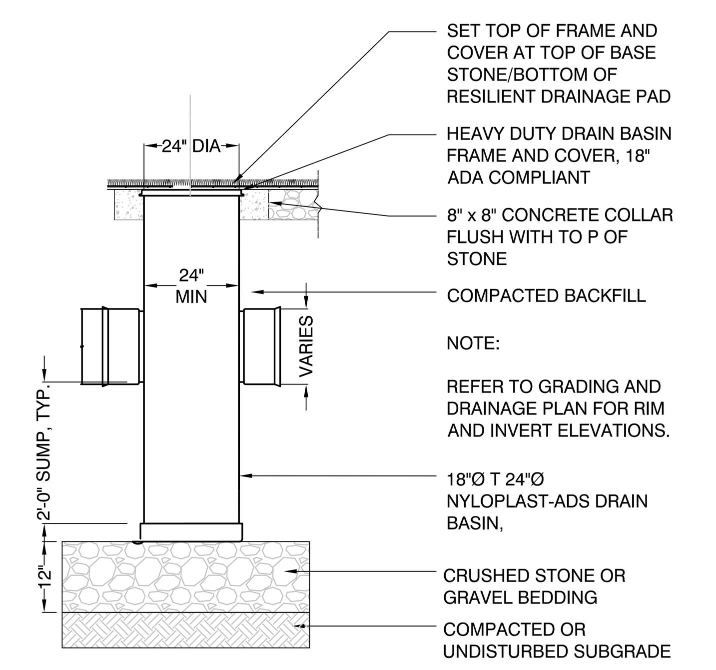
1. IN LINE DRAIN BASINS SHALL BE INSTALLED WITHIN THE SUBSURFACE DETENTION BASIN REACH AND SEALED AT THE TOP PENETRATION USING USING STAINLESS STEEL LINER CLAMPS.
2. INLET AND OUTLET PIPES ORIGINATE AT THE PERMAVOID BASINS



14 IN LINE DRAIN BASIN (ILD)- AT SYNTHETIC TURF TYP
N.T.S.

NOTES:

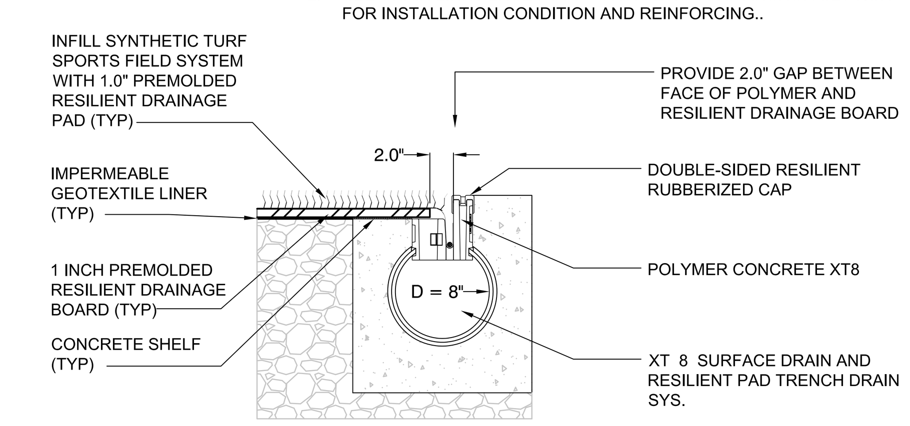
1. SYNTHETIC TURF DRAIN INLETS (SDTI) SHALL BE SIZED BY THE MANUFACTURER BASED ON THE NUMBER AND ORIENTATION OF PIPING. BASINS SHALL BE 2 TIMES THE LARGEST PIPE DIAMETER ENTERING EACH BASIN.
2. WHERE PLACEMENT OF PIPING CREATES ALIGNMENT AND SEPARATION CONCERNS SMALLER DIAMETER PIPING CAN ENTER EACH BASIN USING A 45 DEGREE ELBOW.



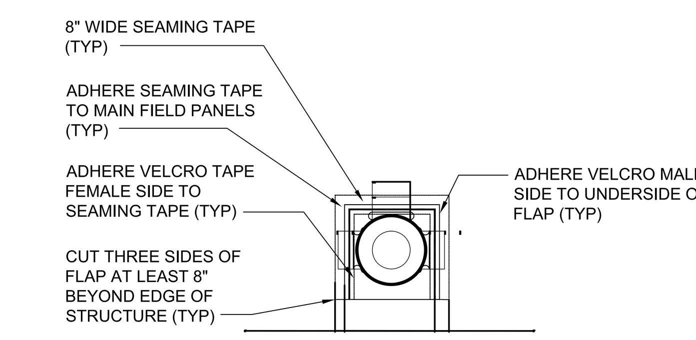
13 SYNTHETIC TURF DRAIN INLET BASIN (SDTI)- AT SYN. TURF TYP
N.T.S.

NOTES:

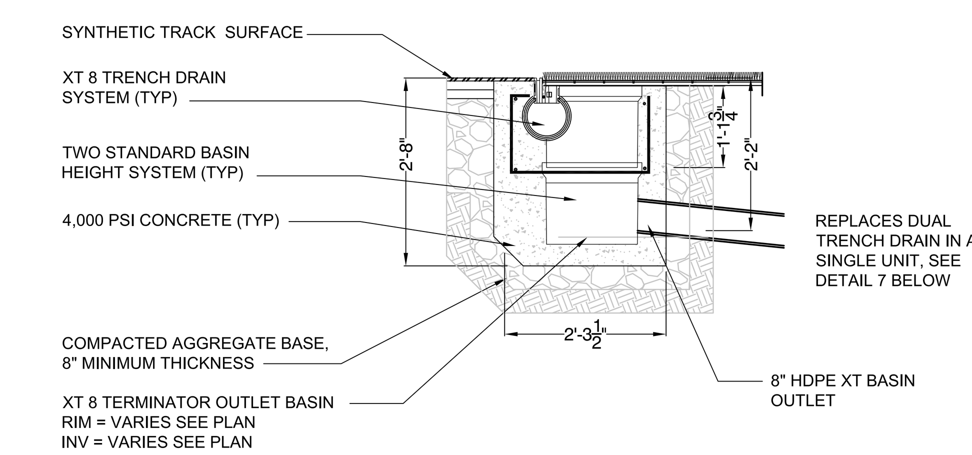
1. REPLACES DUAL TRENCH DRAIN IN A SINGLE UNIT, SEE DETAIL 8 BELOW.
2. SEE CHAIN LINK FENCE POST - SYNTHETIC TURF ANCHOR SECTION FOR INSTALLATION CONDITION AND REINFORCING..



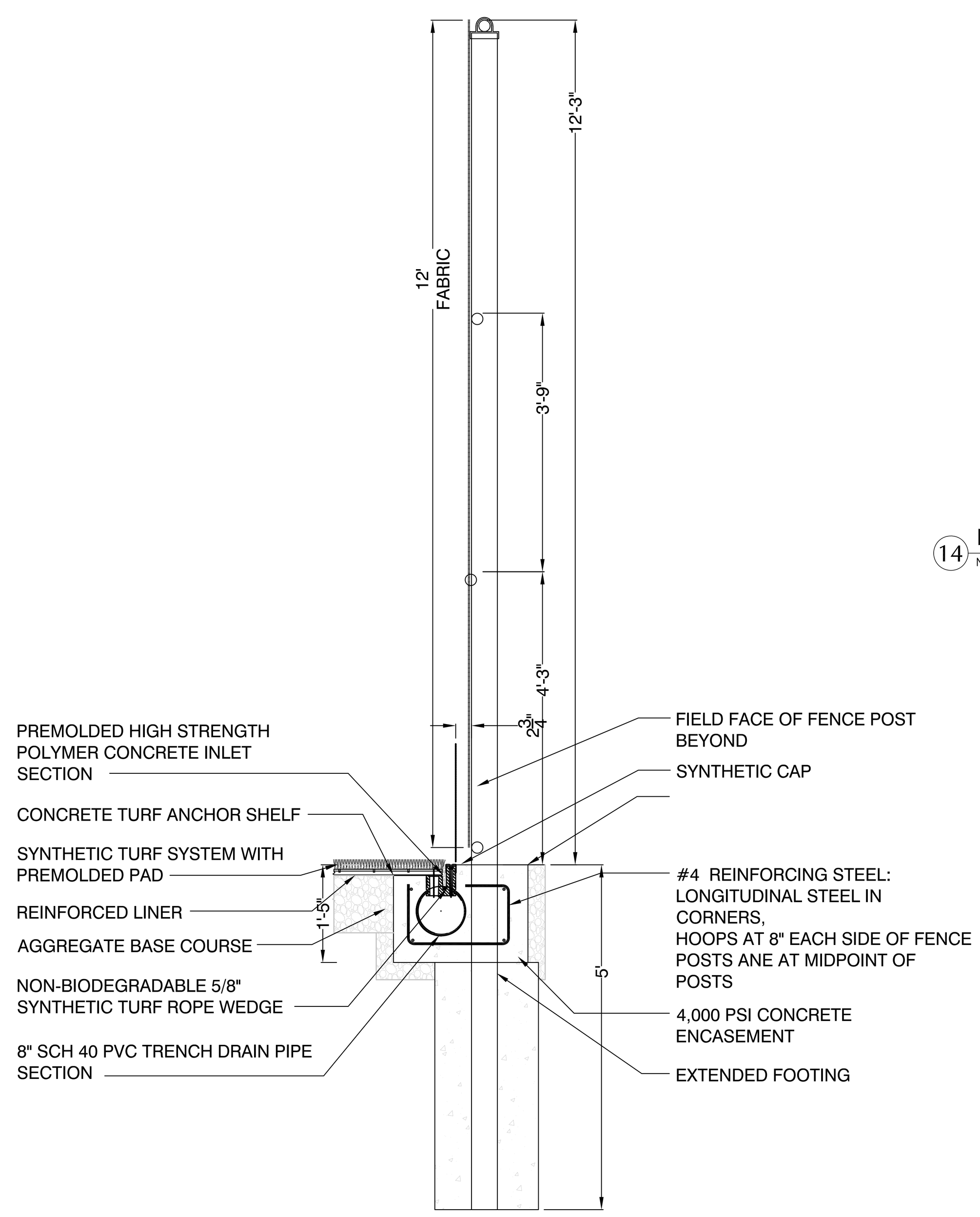
12 INTEGRAL SURFACE/RESILIENT PAD TRENCH DRAIN (TYP)
N.T.S.



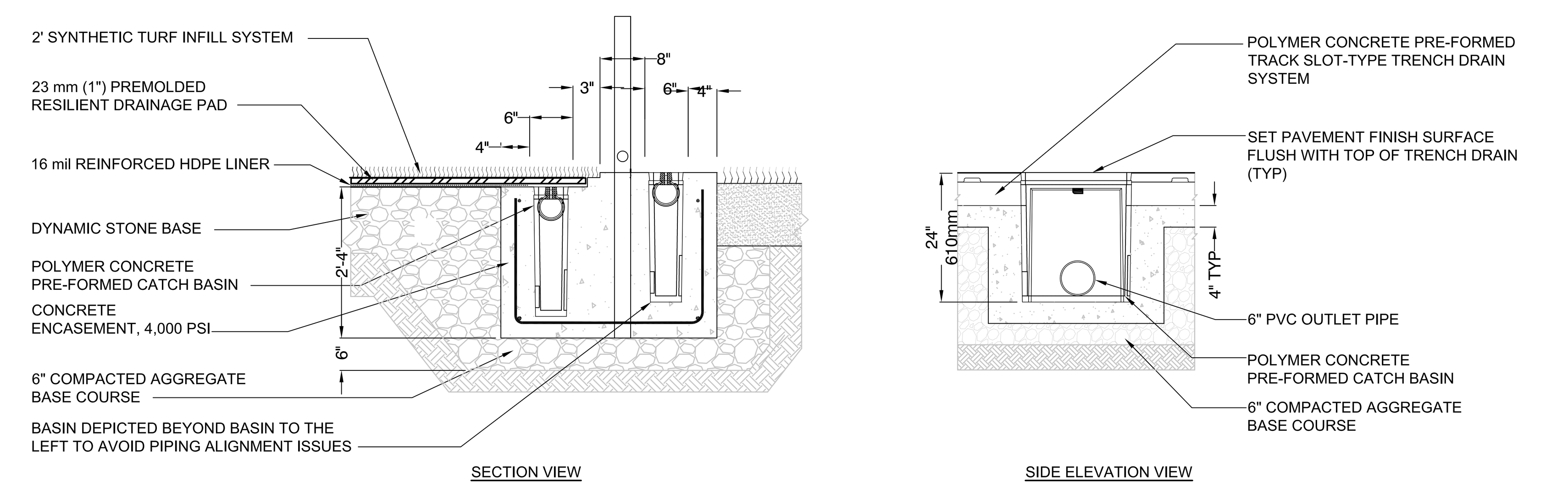
14 TURF COVER AT FIELD BASINS AND MANHOLES, TYP.
N.T.S.



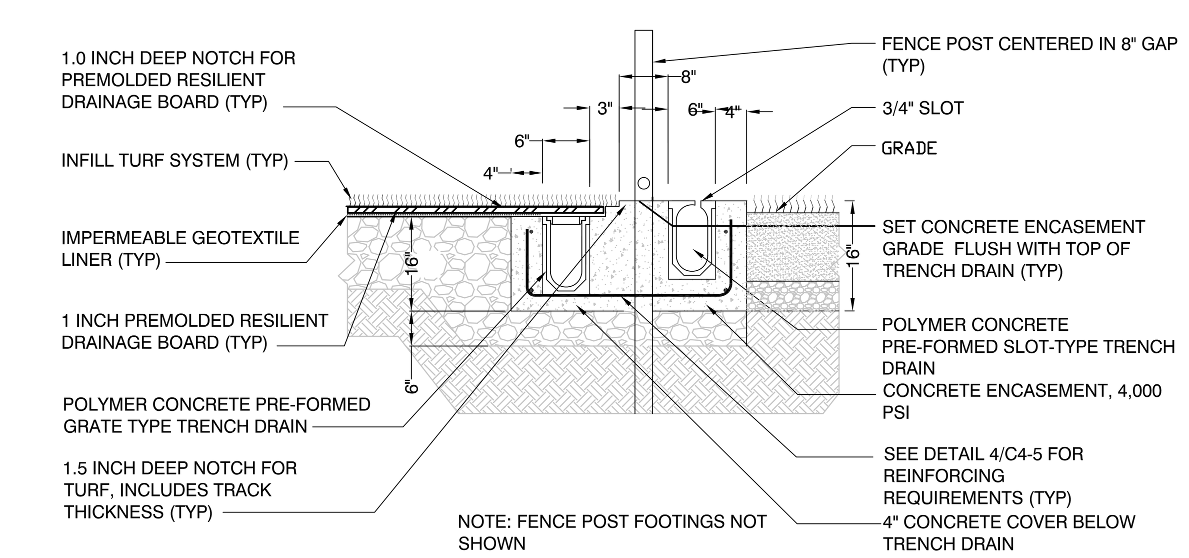
11 TRENCH DRAIN BASIN AT INTEGRAL SURFACE/RESILIENT PAD TRENCH DRAIN
N.T.S.



10 CHAIN LINK FENCE POST 12'-3" HEIGHT - SYNTHETIC TURF ANCHOR SECTION
N.T.S.



9 DUAL TRENCH DRAIN BASIN AT SYNTHETIC TURF - SECTION
N.T.S.



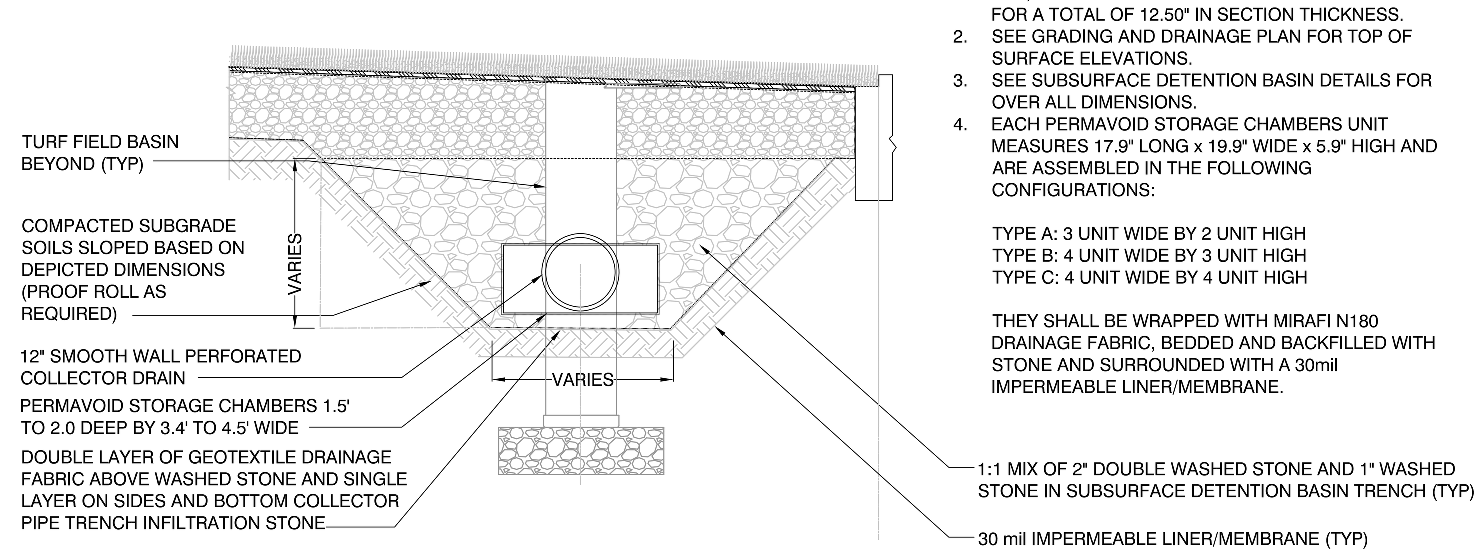
8 DUAL TRENCH DRAIN AT SYNTHETIC TURF SPORTS FIELD, TYP.
N.T.S.

NOTES:

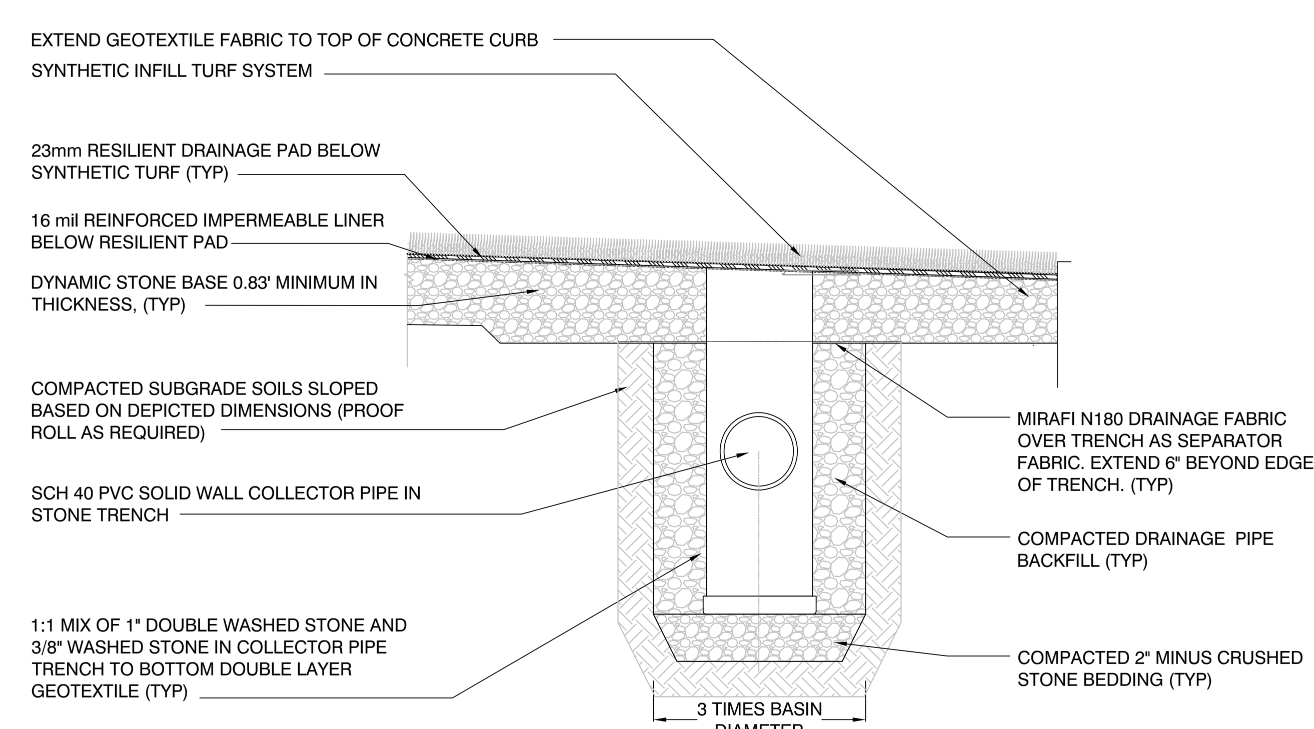
1. CROSS-SECTION ASSUMES THAT THE DYNAMIC STONE TOTAL THICKNESS IS 10", REINFORCED HDPE LINER AND PREMOLDED RESILIENT DRAINAGE PAD IS 1.0" , AND THE SETTLED INFILL DEPTH IS 1.50" INCH FOR A TOTAL OF 12.50" IN SECTION THICKNESS.
2. SEE GRADING AND DRAINAGE PLAN FOR TOP OF SURFACE ELEVATIONS.
3. SEE SUBSURFACE DETENTION BASIN DETAILS FOR OVER ALL DIMENSIONS.
4. EACH PERMAVOID STORAGE CHAMBERS UNIT MEASURES 17.9" LONG x 19.9" WIDE x 5.9" HIGH AND ARE ASSEMBLED IN THE FOLLOWING CONFIGURATIONS:

TYPE A: 3 UNIT WIDE BY 2 UNIT HIGH
TYPE B: 4 UNIT WIDE BY 3 UNIT HIGH
TYPE C: 4 UNIT WIDE BY 4 UNIT HIGH

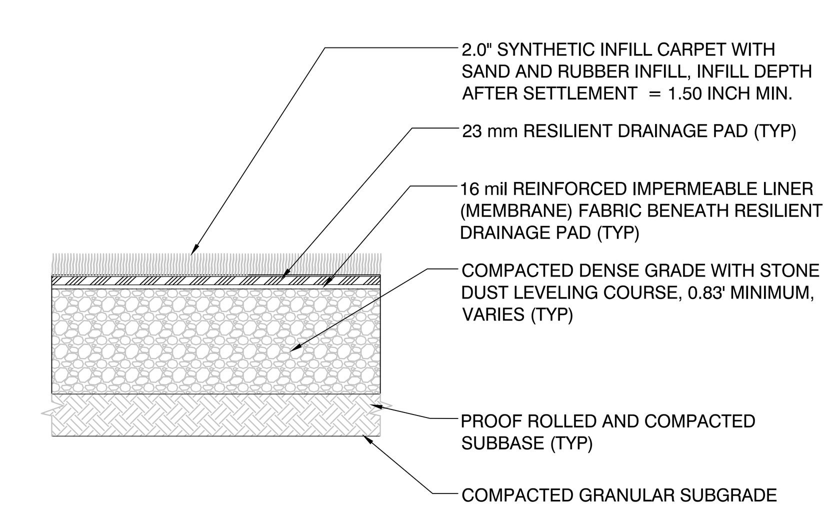
THEY SHALL BE WRAPPED WITH MIRAFI N180 DRAINAGE FABRIC, BEDDED AND BACKFILLED WITH STONE AND SURROUNDED WITH A 30mil IMPERMEABLE LINER/MEMBRANE.



7 SYNTHETIC TURF FIELD LEACHING TRENCH SECTION
N.T.S.



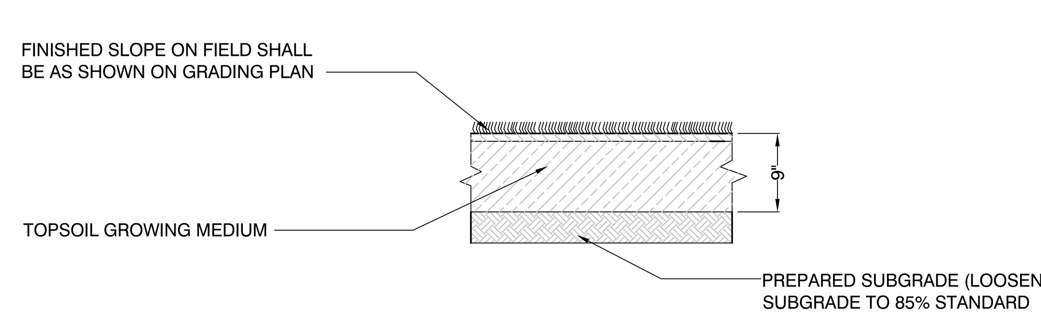
6 COLLECTOR PIPE TRENCH SECTION AT POLYMER DRAIN BASIN(TYP)
N.T.S.



NOTES:

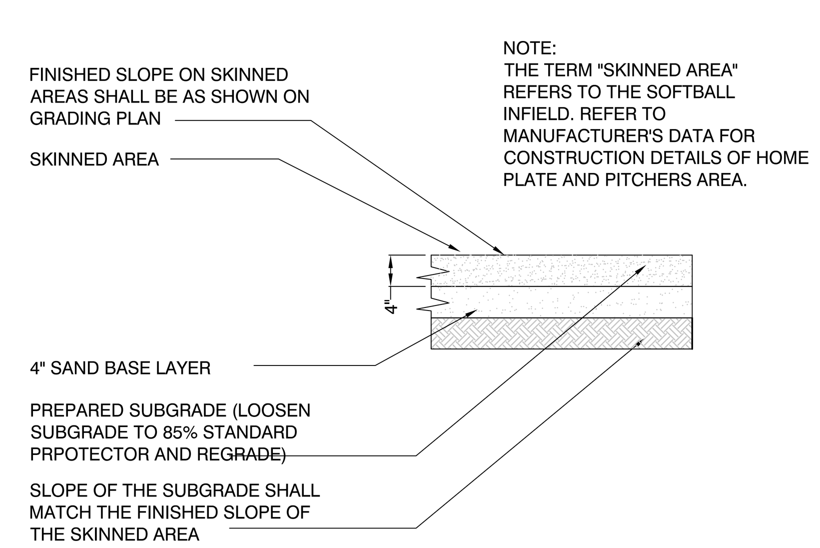
1. INSTALL RESILIENT DRAINAGE PAD IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS (TYP)
2. CONFIRM FINAL GRADE COMPLIANCE BASED ON FIELD ASBUILT AND STRING LINES AS REQUIRED IN TECHNICAL SPECIFICATIONS.
3. COMPACT DENSE GRADE AND TOPPING STONE BASE USING STATIC ROLLING PROCESS. THE USE OF VIBRATION MUST BE APPROVED BY THE ENGINEER. THICKNESS OF DYNAMIC STONE 0.83' MINIMUM (VARIES) TOTAL, CONSISTING OF 0.75' TO 0.77' OF BASE STONE AND 0.04' TO 0.06' OF TOPPING STONE. FOR A TOTAL OF 0.83' (TYP)
4. 16 mil GEOTEXTILE IMPERMEABLE LINER (MEMBRANE)TO BE INSTALLED BENEATH PAD FOR FULL EXTENT OF PAD. LINER TO EXTEND ONTO AND BE SEALED TO ANCHOR CURB SYSTEM.
5. DENSE GRADE STONE BASE ELEVATIONS SHALL MEET A TOLERANCE OF + OR - 0.02 FEET FROM DESIGN GRADES BASED ON A 20 FOOT GRID ASBUILT SURVEY.

5 SYNTHETIC TURF FIELD SECTION
N.T.S.

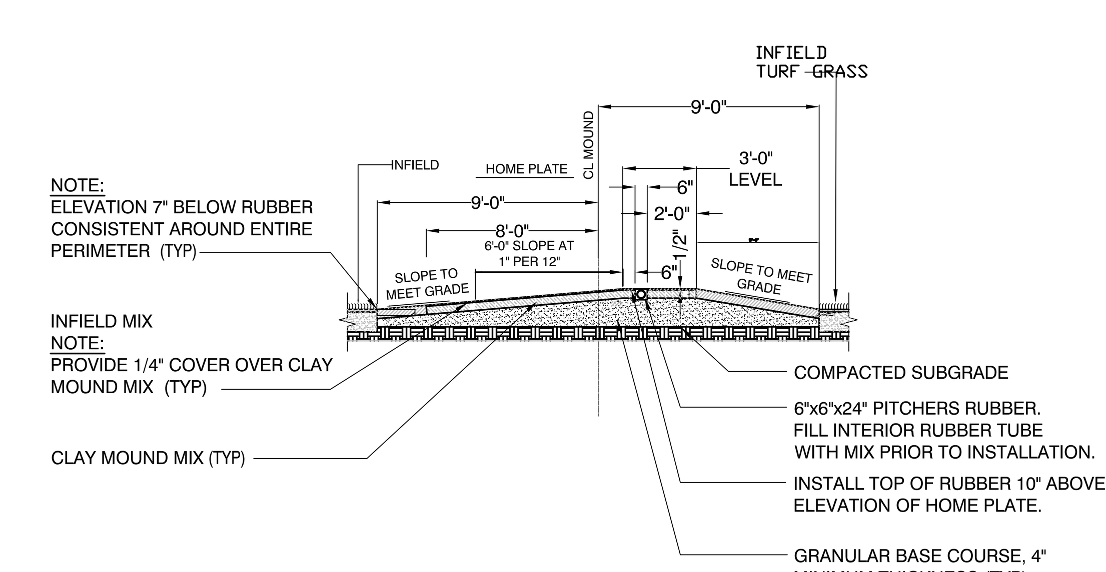


4 BLENDED SOIL/SAND BASED GROWING MEDIUM AT BULL PEN

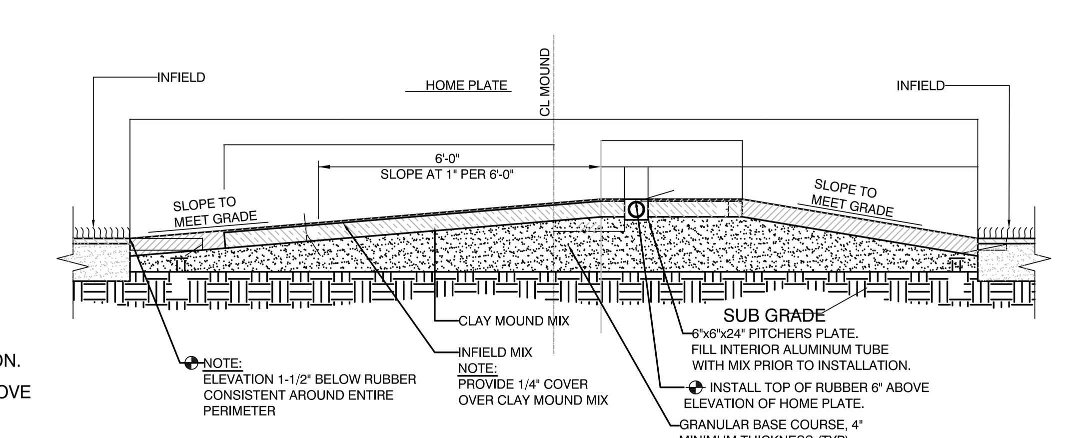
NOTE:
THE TERM "SKINNED AREA" REFERS TO THE SOFTBALL INFIELD. REFER TO MANUFACTURER'S DATA FOR CONSTRUCTION DETAILS OF HOME PLATE AND PITCHERS AREA.



3 SKINNED AREA SECTION AT BULL PEN



2 BASEBALL NATURAL TURF GRASS MOUND AT BULLPEN - SECTION
NOT TO SCALE



1 SOFTBALL NATURAL TURF GRASS MOUND AT BULLPEN- SECTION
NOT TO SCALE

KEYPLAN

REVISIONS NO.	DATE	REMARKS	BY

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JOHN J. AMATO No. 24799

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JJASPORTS.COM

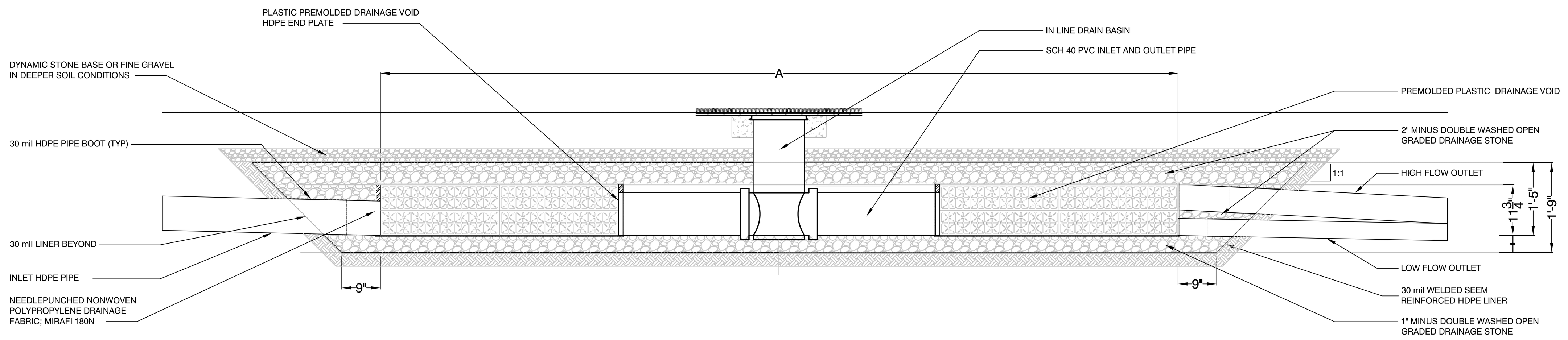
CONSERVATION FILING SET
05-07-2020

Arlington High School
Massachusetts Avenue, Arlington, Massachusetts
Outdoor Athletic Improvements
Details

DRAWN BY: J AMATO CHECKED BY: J AMATO
SCALE: NTS

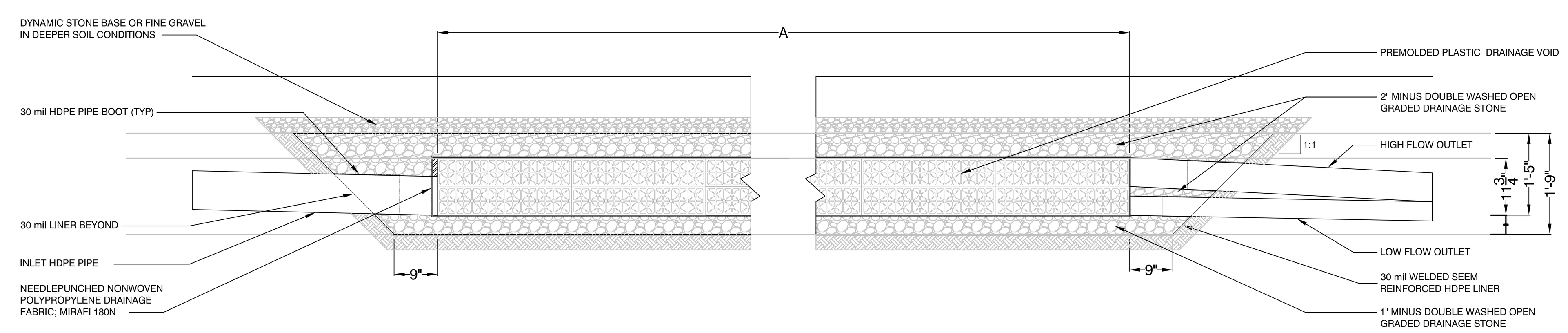
DRAWING NUMBER
L8.7

JOB NUMBER 408417



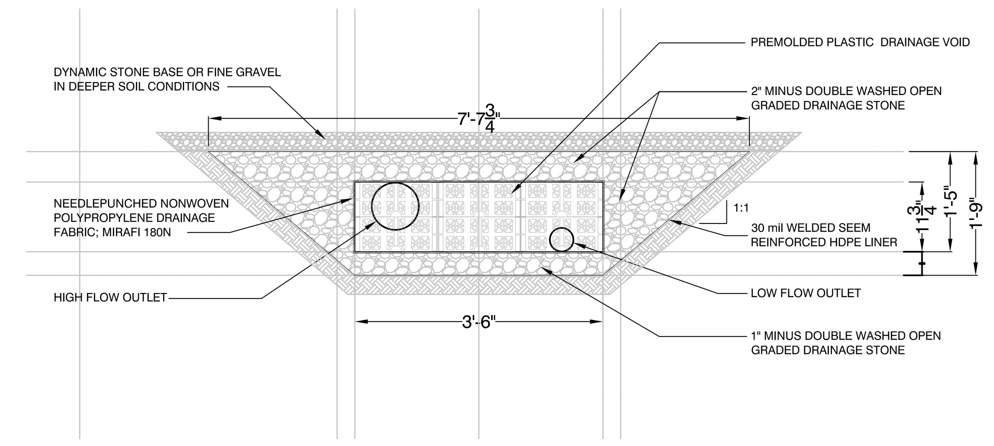
7 SUBSURFACE DETENTION BASIN TYPE A - PROFILE AT IN LINE DRAIN BASIN

NOT TO SCALE



6 SUBSURFACE DETENTION BASIN TYPE A - PROFILE

NOT TO SCALE



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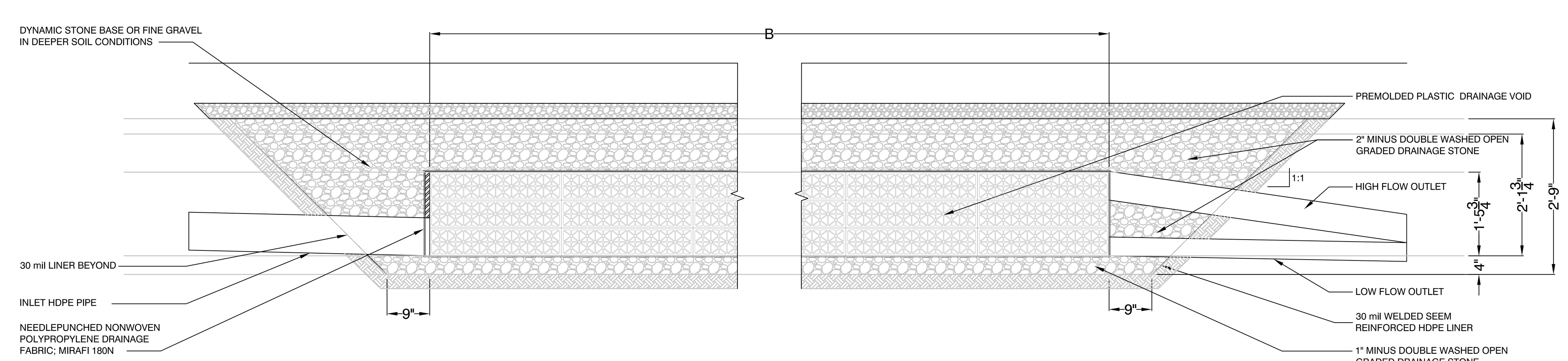

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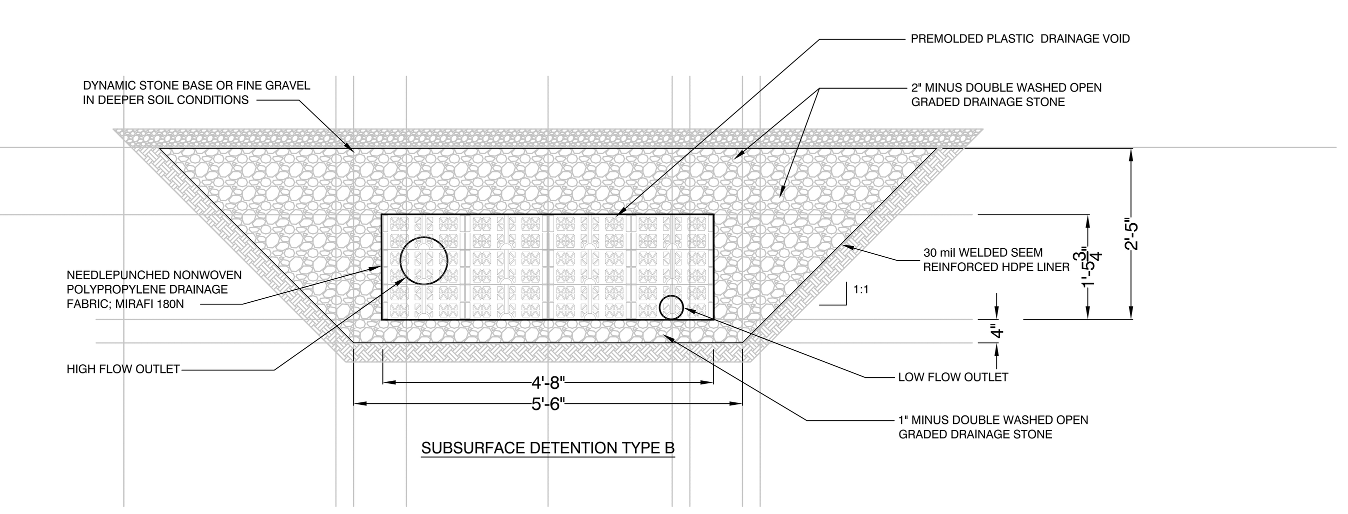

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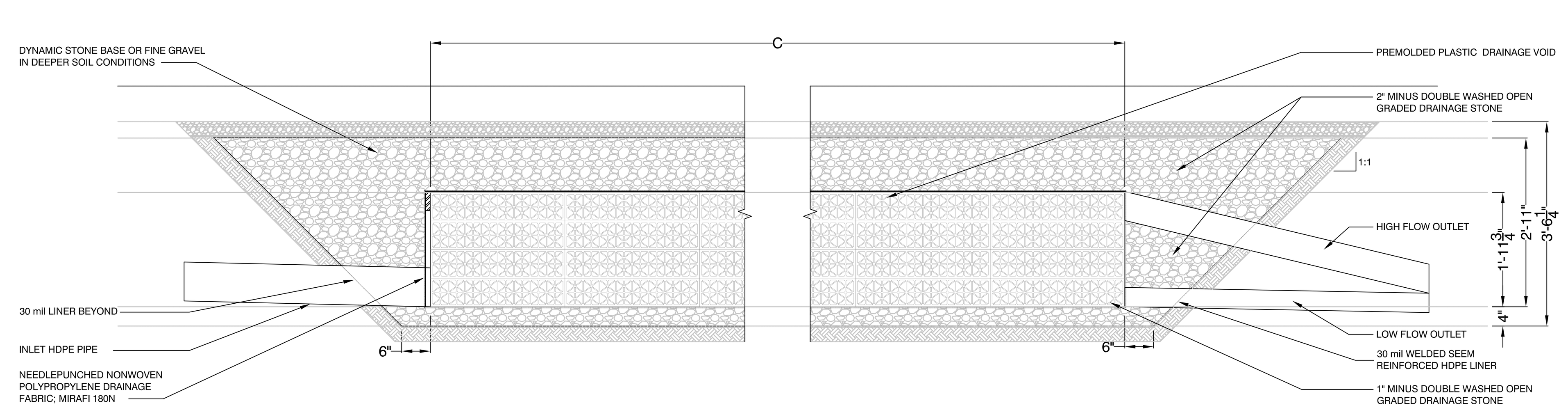

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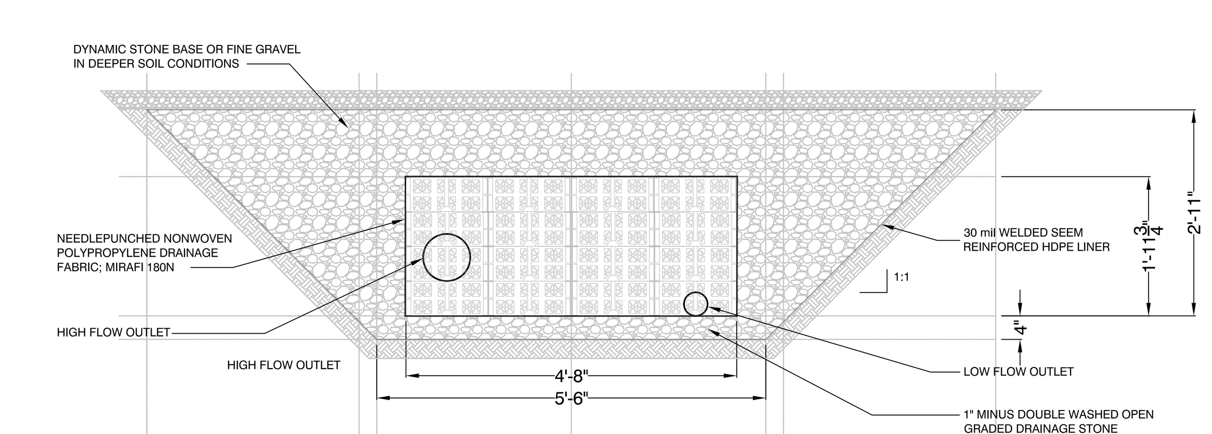

1 SUBSURFACE DETENTION BASIN TYPE C - SECTION

NOT TO SCALE

HMFH

HMFH ARCHITECTS

130 Bishop Allen Drive
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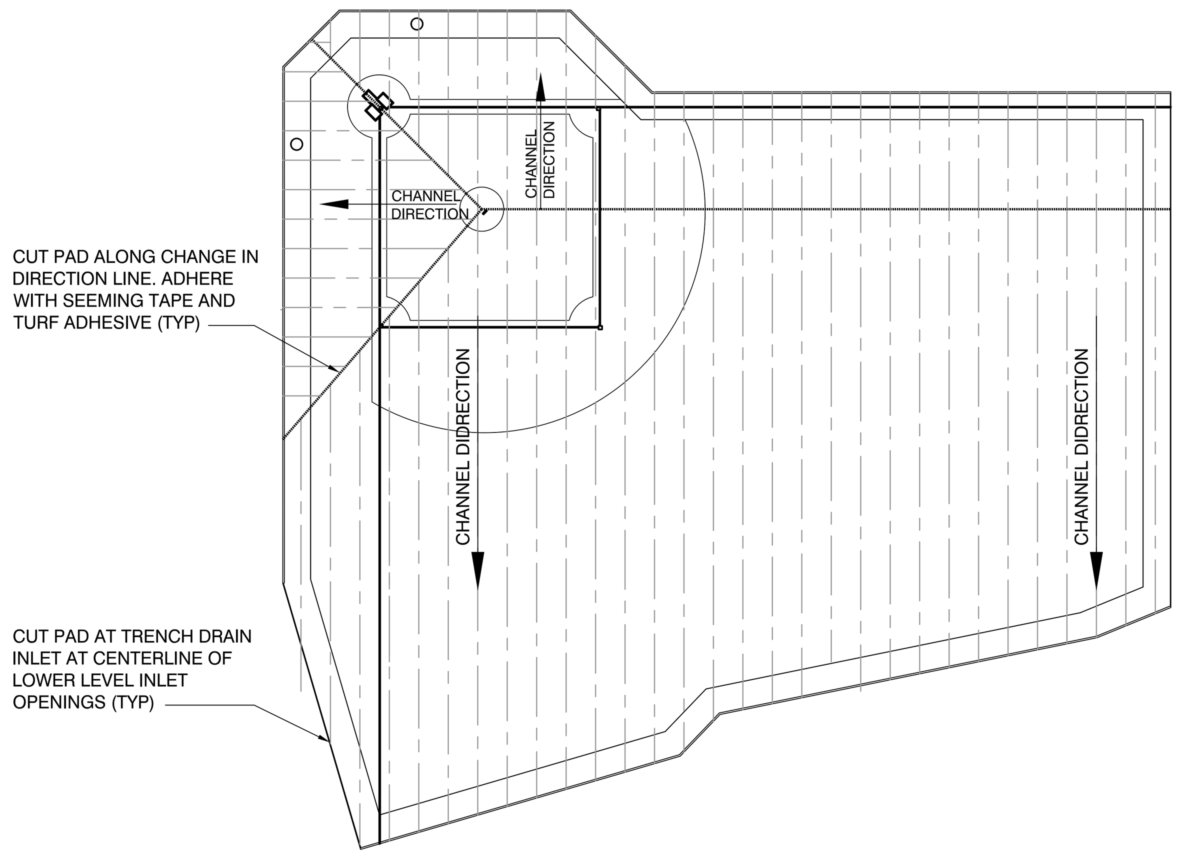
CONSERVATION FILING SET
05-07-2020

KEYPLAN

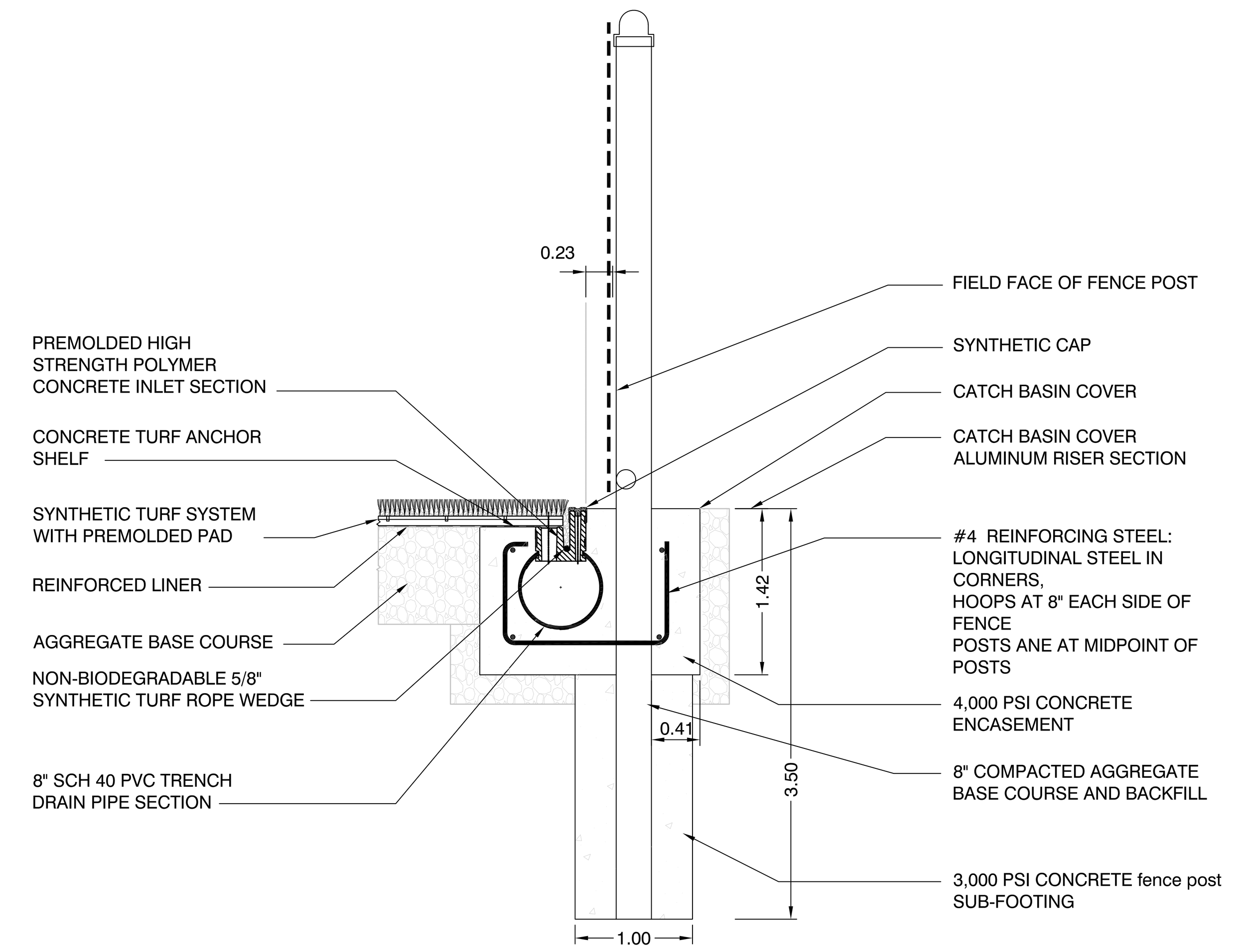
Arlington High School
Massachusetts Avenue, Arlington, Massachusetts
Outdoor Athletic Improvements
Details
SCALE: NTS
DRAWN BY: J AMATO CHECKED BY: J AMATO

REVISIONS NO.	DATE	REMARKS	BY

DRAWING NUMBER
L8.8



8 PREMOLDED DRAINAGE PAD CHANNEL ALIGNMENT PLAN
N.T.S.



7 CHAIN LINK FENCE POST 51" HEIGHT - SYNTHETIC TURF ANCHOR SECTION
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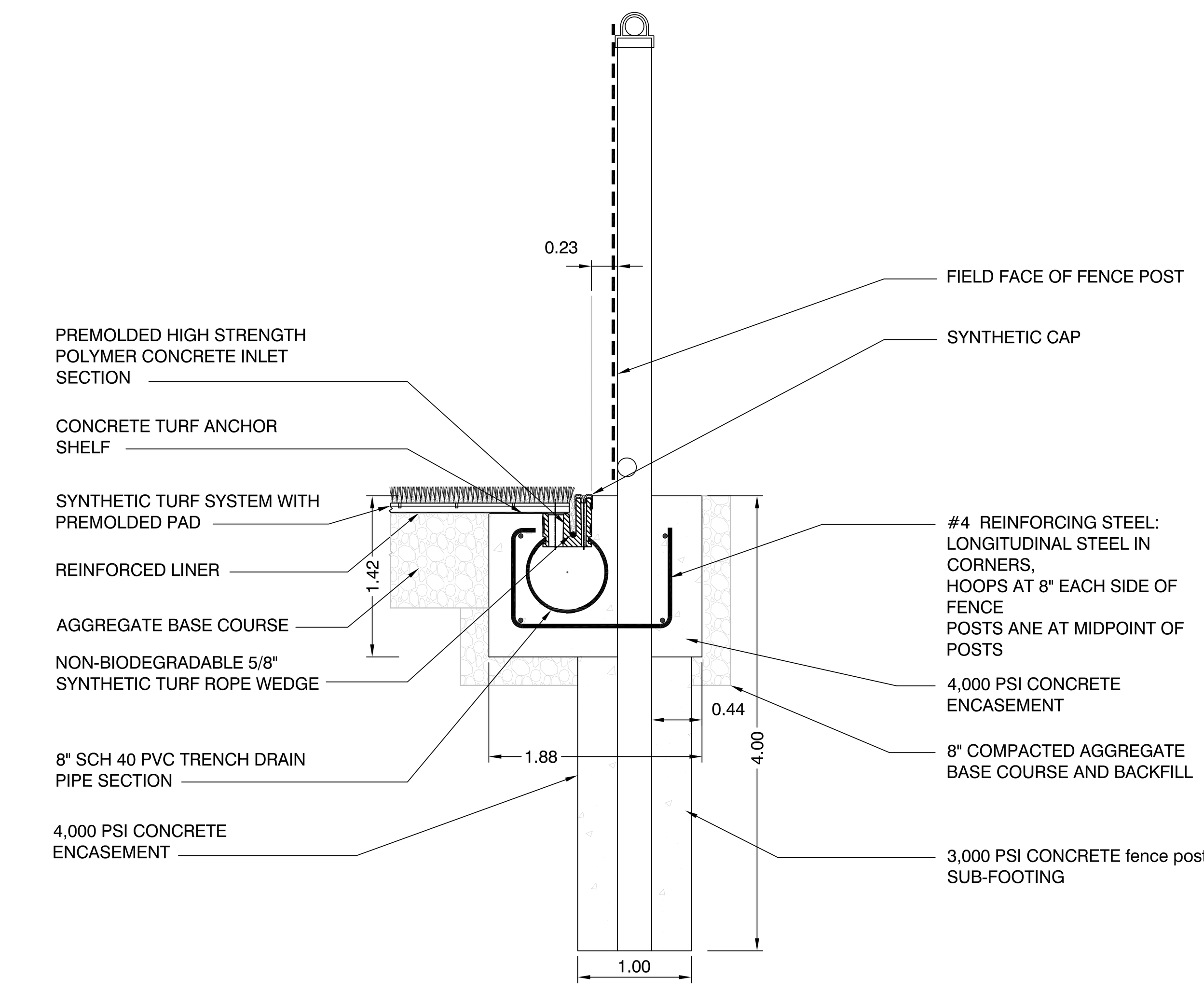

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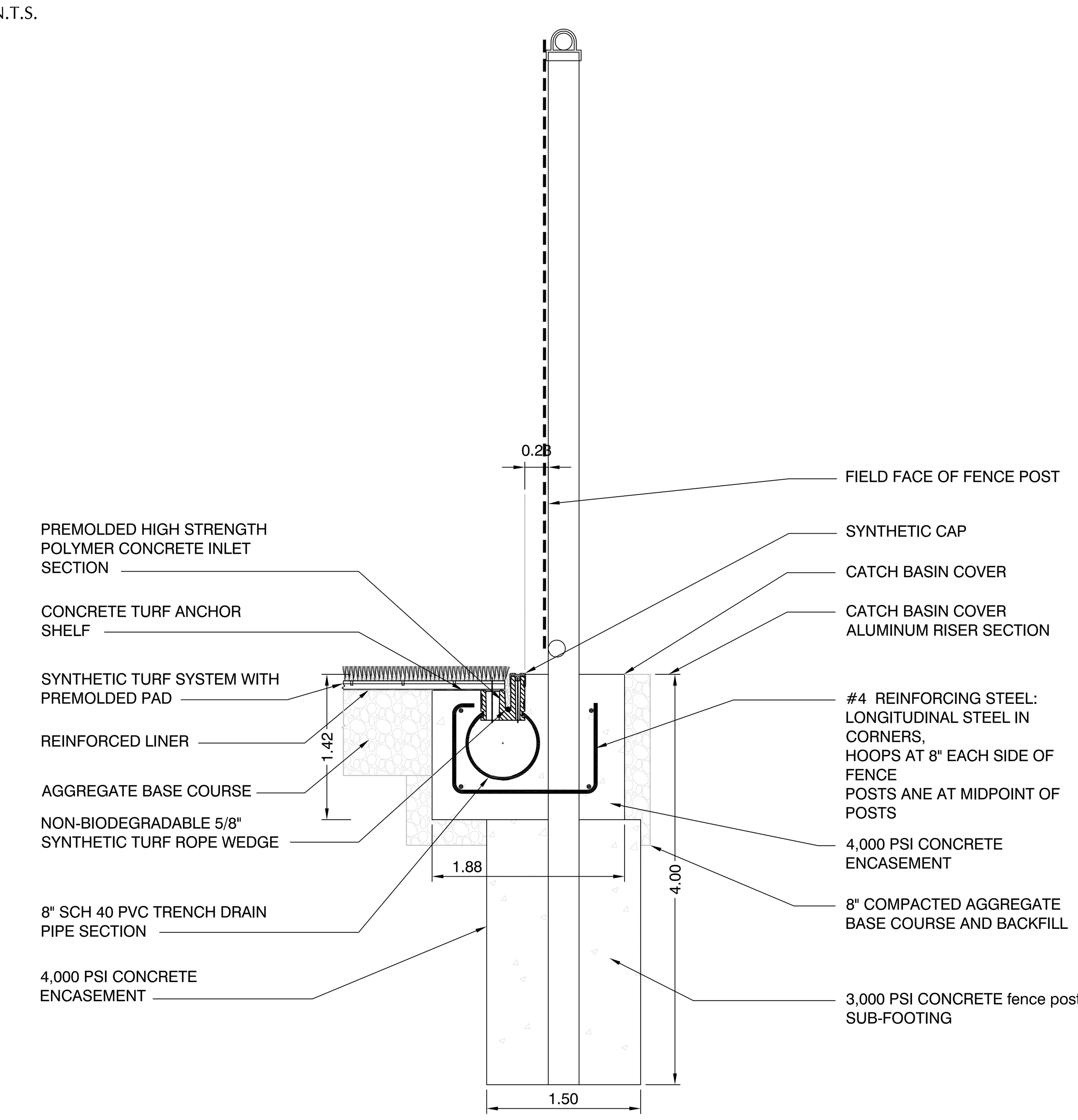

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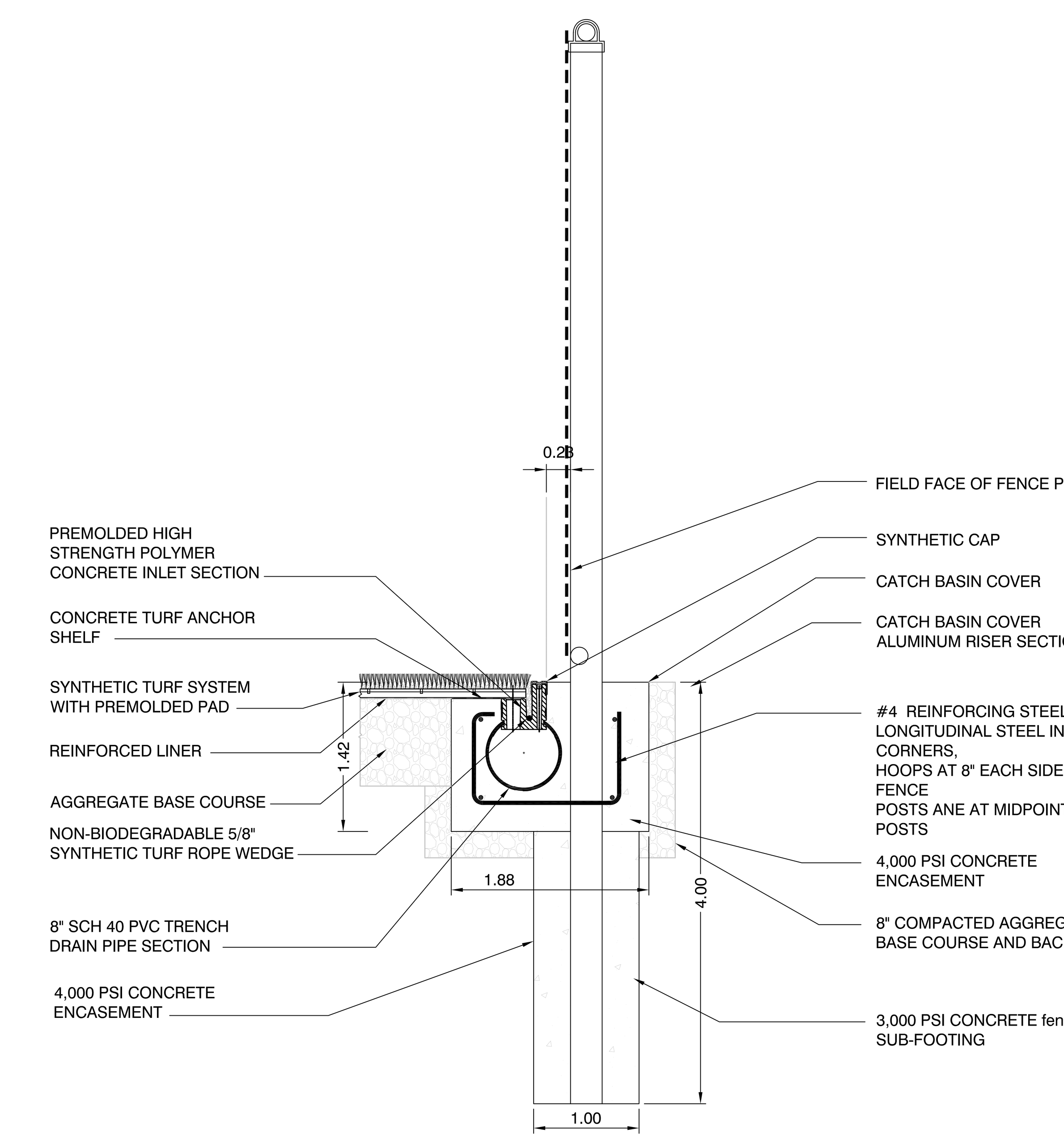

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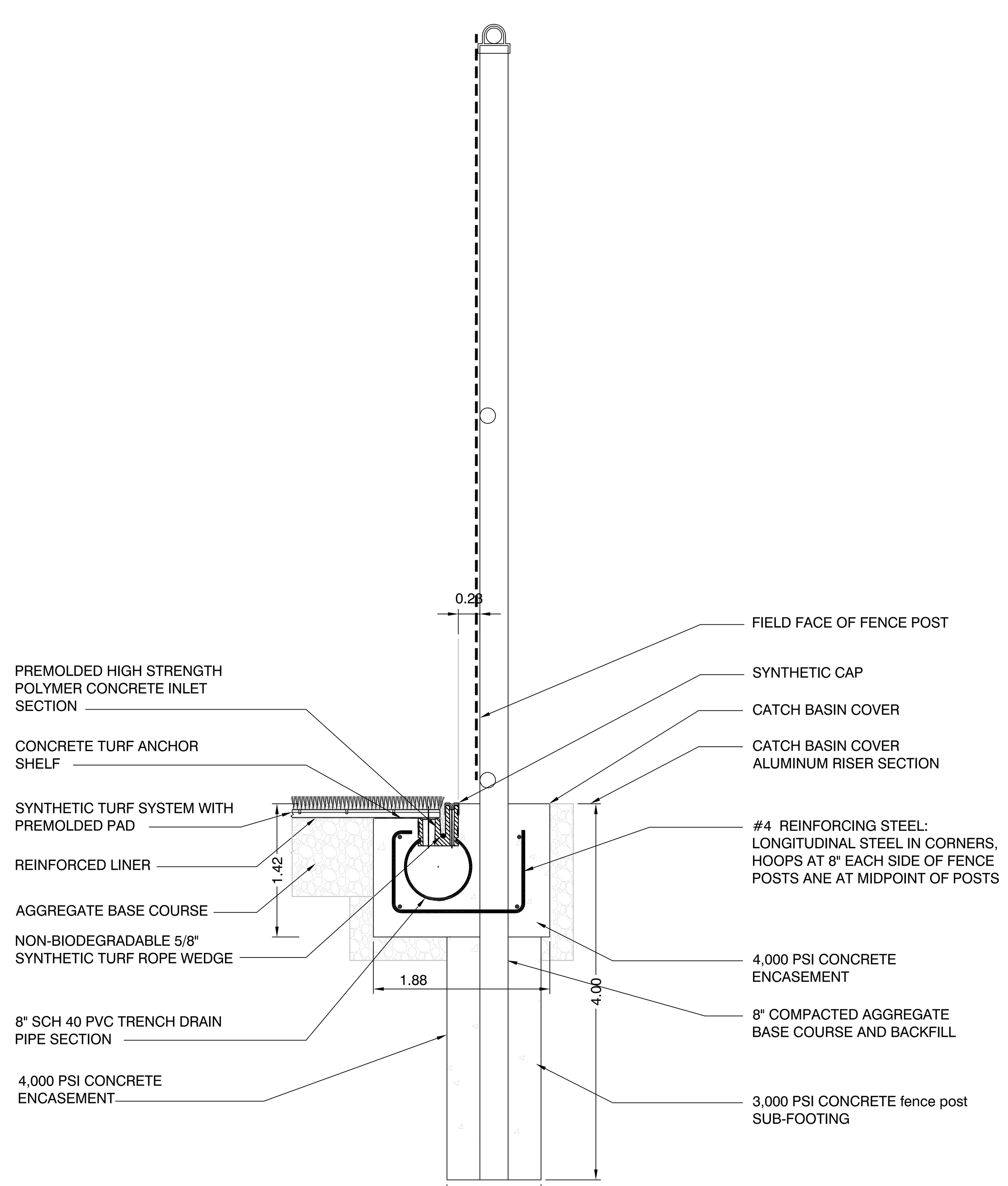

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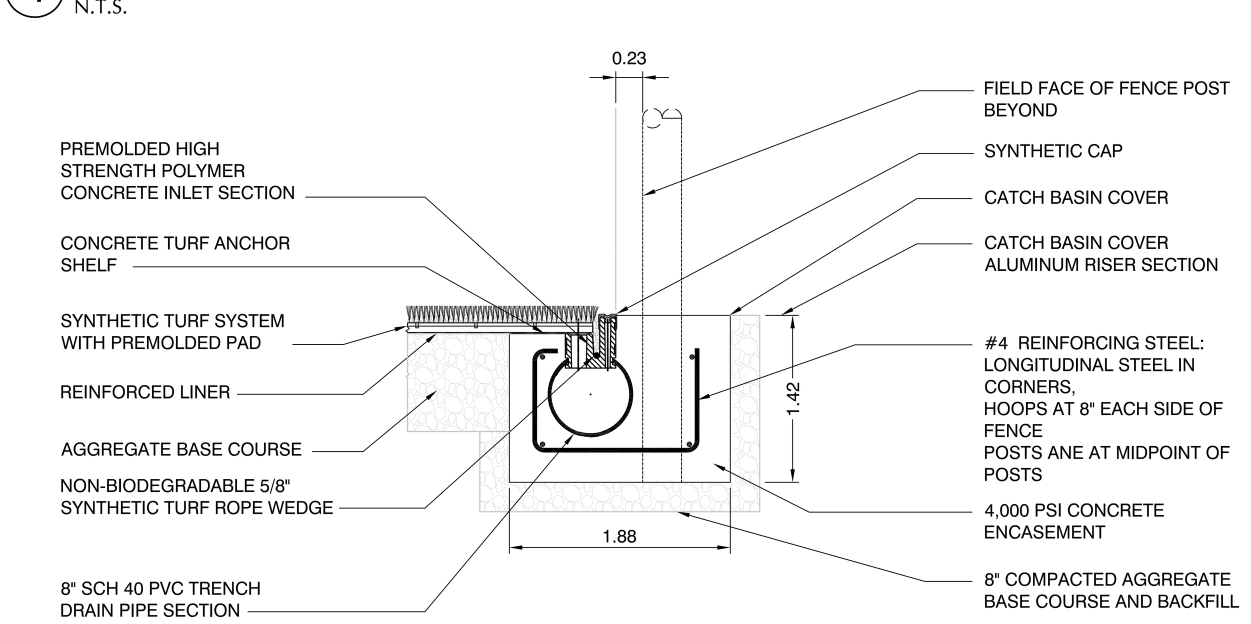

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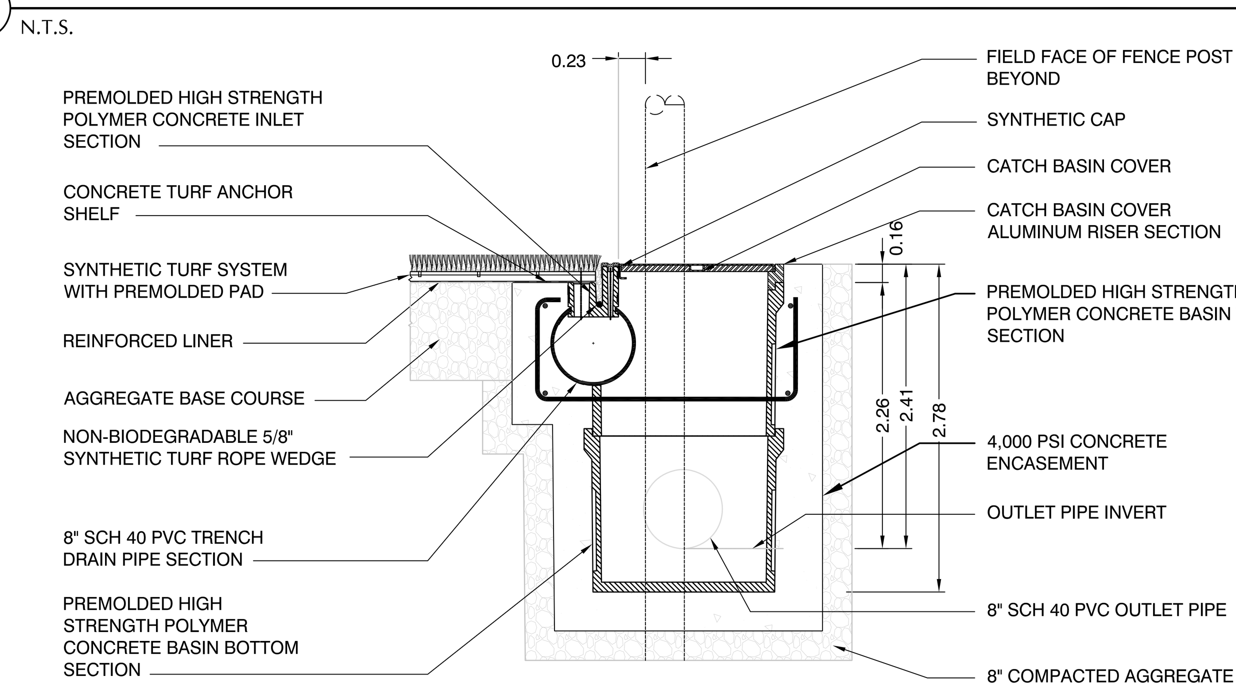

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N.T.S.

HMFH
HMFH ARCHITECTS

JJA SPORTS, LLC

CONSERVATION FILING SET
05-07-2020

KEYPLAN

REVISIONS NO.	DATE	REMARKS	BY

Arlington High School
Massachusetts Avenue, Arlington, Massachusetts
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Details
SCALE: NTS
DRAWN BY: J AMATO CHECKED BY: J AMATO

DRAWING NUMBER
L8.9

ARLINGTON HIGH SCHOOL
869 MASSACHUSETTS AVENUE
Arlington, MA 02476

STORMWATER REPORT

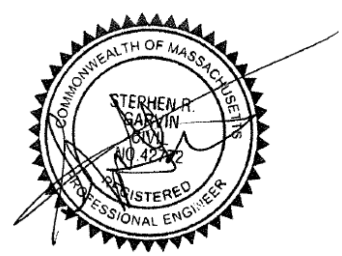
Submitted to:
Town of Arlington Conservation Commission,
Massachusetts Department of Environmental Protection

Applicant:
Town of Arlington
730 Massachusetts Avenue
Arlington, MA 02476

Architect:
HMFH Architects, Inc.
130 Bishop Allen Dr.
Cambridge, MA 02139

Landscape Architect:
Crosby / Schlessinger / Smallridge LLC
67 Batterymarch St., 2nd Floor
Boston, MA 02110

Civil Engineer/Land Surveyor:
Samiotes Consultants, Inc.
20 A Street
Framingham, MA 01701



samiotes

07 May 2020

ARLINGTON HIGH SCHOOL
STORMWATER MANAGEMENT NARRATIVE
ARLINGTON, MA

Introduction:

The existing site, located at 869 Massachusetts Avenue, Arlington, MA, consists of the Arlington High School campus, containing the existing Arlington High School Building with an associated paved driveways, landscaped areas, and utilities as well as grass athletic fields, a turf football field, and facilities. There are several accessory structures across the property for equipment storage and bathroom facilities for the fields. The property is abutted by the Minuteman Commuter Bikeway on the north side, a condominum complex, church, and pharmacy on the east side, and a series of residences and the Francis N. O'Hara building on the west side. The site slopes approximately 35 feet from south to north, with the high point of the site being at Massachusetts Ave. and the low point being on the east side of the site at the end of the Mill Brook culvert. Mill Brook flows through the site from west to east between the existing building and the football stadium via a subsurface concrete box culvert. which splits into two corrugated metal culverts on the east side of the existing building before daylighting on the east side of the site adjacent to Mill Street Extension.

The proposed project includes a new 143,025 square foot High School building footprint with associated new paved parking areas, landscaping, athletic fields, bathroom building, utilities and a new stormwater management system in accordance with the Massachusettss DEP Stormwater Standards. The existing football stadium will remain as is and is not within the scope of this project.

Existing Site Hydrology:

In the existing condition, site drainage is handled by a series of "daisy-chained" catch basins that capture stormwater flows and conveys it via underground stormwater piping to the Mill Brook culvert. There is also a large existing culvert, consisting of a 36" reinforced concrete pipe (RCP), that flows under the existing building and discharges to the Mill Brook culvert. This 36" culvert carries a large upgradient offsite watershed from South of the project site that measures over 4,500,000 sf (105+ Ac). See figure within the appendices of this report. Historically this culvert has been shown to be undersized and has caused flooding and floor buckling within the basement of the High School.

From a stormwater treatment perspective, there is an existing oil/water separator unit on the north side of the building, however this structure only treats a single catchment area of a much larger impervious area on-site. The field areas and football stadium have underdrainage system that ties into the Mill Brook culvert as well.

According to FEMA flood mapping, the site is located within Zones X and AE (see FEMA Firmette Map within the appendices of this report). These flood zones are depicted graphically on the civil design plans and existing conditions plans per the FEMA delineation. However, after a field survey of elevations present at the site, we have concluded that the flood elevations shown on the FEMA mapping are held within the banks of the Mill Brook and do not encroach on the site. During the last major renovation at the school, there was a small area on the east side of the school dedicated for compensatory storage.

Methodology/ Procedure

The proposed Stormwater Management system will include several stormwater Best Management Practices (BMPs) consisting of deep sump catch basins, water quality treatment units, an underground

infiltration system, and three (3) lined rain gardens used for filtration. See the Proposed Watersheds section within this report for detailed information about the proposed BMPs for each watershed included in the stormwater management design.

Watershed Routing

Below is a summary of the various existing and proposed watersheds with a brief narrative describing the routing. The watersheds are depicted in sketches Ex-HYD and P-HYD located in the appendices of this report. The hydrology maps show a single point of analysis (POA) in both the existing conditions and the proposed conditions. POA-1 represents the culmination point of stormwater flows across the site within Mill Brook on the east side of the site.

<u>Existing Watersheds:</u>

Ex- Watershed-1: This watershed consists of the existing high school building, fields, paved parking areas and landscaped areas across the site. Stormwater from this watershed sheet flows overland to existing catch basins across the site, which are conveyed via existing underground piping to the existing drainage systems on the north side of the site before discharging to Mill Brook, defined as POA-1.

<u>Proposed Watersheds:</u>

P- Watershed-1: This watershed consists of paved parking areas, pedestrian walkways, and landscaped areas that sheet flow overland to the proposed deep sump catch basins, where it is then conveyed to a proposed water quality unit prior to discharging to the culertized portion of Mill Brook on the east side of the site, defined as Point of Analysis 1 (POA-1).

P- Watershed-1A: This watershed consists of a portion of the paved parking area and landscaped area on the east side of the site. Stormwater sheet flows overland to proposed deep sump catch basins, where it is then conveyed to a proposed water quality unit prior to discharging to Mill Brook on the east side of the site, defined as Point of Analysis 1 (POA-1).

P- Watershed-1B: This watershed consists of the northwest portion of the proposed building. Stormwater is collected and piped underground via roof drain piping to the culvertized portion of Mill Brook, defined as Point of Analysis 1 (POA-1).

P- Watershed-1C: This watershed consists of pedestrian walkways, landscaped areas, and wooded areas on the east edge of the site. Stormwater sheet flows that do not discharge directly to Mill Brook flow overland to the abutting property where they eventually culminate at Mill Brook on the east side of the site, defined as Point of Analysis 1 (POA-1).

P- Watershed-1D: This watershed consists of the southern portion of the proposed building. Stormwater is collected and piped underground via roof drain piping to an existing drain pipe that discharges to Mill Brook on the east side of the site, defined as Point of Analysis 1 (POA-1).

P- Watershed-1E: This watershed consists of pedestrian walkways and landscaped areas that sheet flow overland to the proposed area drains, where it is then conveyed to the culertised portion of Mill Brook on the east side of the site via underground piping, defined as Point of Analysis 1 (POA-1).

P- Watershed-2: This watershed consists of stormwater flows from the parking area, play area, and landscaped area on the east side of the site. Stormwater flows overland to proposed deep sump catch basins and is conveyed via underground pipe to a proposed underground infiltration system (UGS-1). In larger storm events, flows will discharge via an outlet control structure (OCS-1) and underground piping to an existing drain pipe that discharges to Mill Brook, defined as POA-1.

P- Watershed-2B: This watershed consists of the eastern portion of the proposed building. Stormwater is collected and piped underground via roof drain piping to a proposed underground infiltration system (UGS-1). In larger storm events, flows will discharge via an outlet control structure (OCS-1) and underground piping to an existing drain pipe that discharges to Mill Brook, defined as POA-1.

P- Watershed-3A: This watershed consists of paved parking areas, the Shouler Court paved roadway, pedestrian walkways, amphitheater area, and landscaped areas on the west side of the site that sheet flow overland to proposed deep sump catch basins. Stormwater flows are conveyed via underground piping to a proposed lined Rain Garden (RG-1). Stormwater passes through the soil media and the lined bioretention area channels the filtered stormwater through a perforated underdrain pipe at the bottom of the bioretention system that discharges to another proposed Rain Garden (RG-2), which also has an underdrain pipe collecting flow and discharging to the third Rain Garden (RG-3). This bioretention area has an underdrain and outlet control structure (OCS-2) discharging to the stormwater trunk line running along the north side of the proposed building. Flows from this trunk line are discharged to the culvertized portion of Mill Brook on the east side of the site, defined as Point of Analysis 1 (POA-1). Note that the proposed Rain Garden (RG-1) has an emergency spillway weir for larger storm events, which discharges to RG-2.

P- Watershed-3B: This watershed consists of paved parking areas and landscaped areas, as well as flows from the upstream RG-1 (see P-Watershed-3A description) on the west side of the site that sheet flow overland to proposed deep sump catch basins. Stormwater flows are conveyed via underground piping to a proposed lined Rain Garden (RG-2). Stormwater passes through the soil media and the lined rain garden channels the filtered stormwater through a perforated underdrain pipe at the bottom of the rain garden that discharges to another proposed Rain Garden (RG-3), which also has an underdrain pipe and outlet control structure (OCS-2) discharging to the stormwater trunk line running along the north side of the proposed building. Flows from this trunk line are discharged to the culvertized portion of Mill Brook on the east side of the site, defined as Point of Analysis 1 (POA-1). Note that the proposed Rain Garden (RG-2) has an emergency spillway weir for larger storm events, which discharges to RG-3.

P- Watershed-3C: This watershed consists of landscaped areas, as well as flows from the upstream RG-2 (see P-Watershed-3B description) on the west side of the site that sheet flow overland to proposed deep sump catch basins. Stormwater flows are conveyed via underground piping to a proposed lined Rain Garden (RG-3). Stormwater passes through the soil media and the lined rain garden channels the filtered stormwater through a perforated underdrain pipe at the bottom of the rain garden and is collected via an underdrain perforated pipe at the bottom of the rain garden that discharges to the stormwater trunk line running along the north side of the proposed building. Flows from this trunk line are discharged to the culvertized portion of Mill Brook on the east side of the site, defined as Point of Analysis 1 (POA-1). Note that the proposed Rain Garden (RG-3) has an outlet control structure associated with its design for larger storm events, which discharges to the outlet pipe and trunk line.

P- Watershed-4: This watershed consists of pedestrian walkways and synthetic turf soccer field areas on the west side of the site that are collected via underdrain piping and area drains and passed through a series of small detention basins prior to discharging to the trunk line on the north side of the proposed building and ultimately discharging to the culvertized portion of Mill Brook on the east side of the site, defined as Point of Analysis 1 (POA-1).

P- Watershed-5: This watershed consists of pedestrian walkways and synthetic turf baseball field areas on the east side of the site that are collected via underdrain piping and area drains and passed through a series of small detention basins prior to discharging to the culvertized portion of Mill Brook on the east side of the site, defined as Point of Analysis 1 (POA-1).

Flood Storage

As discussed previously within this report the site is graphically located within Flood Zones X and AE per FEMA mapping, but the actual elevations per the Flood Impact Study occur within the banks of the Mill Brook. There is a small compensatory storage area on the east side of the existing building that was for a previous project but not defined by elevations or compensatory storage volumes. This area will be disturbed by the proposed High School project. The proposed project even though not within flood plain elevations will emulate the existing compensatory storage by providing compensatory storage within the stone of the turf fields that far exceed the volume held by the existing flood storage area.

Results/ Summary

Analysis:
The analysis was based on the pre and post development peak discharge rates at the point of analysis. The proposed construction of the school campus will result in an increase in impervious area, therefore the proposed stormwater management system will be designed to mitigate any increase in the rate of runoff and improve stormwater quality in accordance with the requirements of the Massachusetts Stormwater Management Policy Standards.

Results of Analysis:
Through the use of the HydroCAD Software, the curve numbers, times of concentrations, and peak discharge rates were determined for both the existing conditions and the proposed conditions. The results of the study shows that both the post-development peak rates of runoff are equal or less than the existing rates.

As shown in Table 1, the post development peak rates of runoff from the site to each POA will be mitigated.

Table 1 – POA-1 : Peak Rates of Runoff

	2-year storm (cfs)	10-year storm (cfs)	25-year storm (cfs)	100-year storm (cfs)
Existing	21.47	39.53	52.75	76.96
Proposed	20.97	39.44	49.50	69.87

Stormwater Management Standards

The Department of Environmental Protection has implemented the Stormwater Management Standards as of November 18, 1996 and updated them in April 2008. The standards met are described below and in the Stormwater Management Form as provided by DEP.

Standard #1: Untreated Stormwater

The project is designed so that stormwater conveyances (outfalls/discharges) do not discharge untreated stormwater into, or cause erosion to, wetlands or waters.

Therefore Standard #1 is met.

Standard #2: Post-development peak discharge rates

The proposed construction of Arlington High School will result in an overall site increase in impervious area. The proposed stormwater management system has been designed so that there is no increase in post construction discharge rates from the site for each point of analysis by the introduction of stormwater BMPS such as bioretention areas and underground infiltration basins. See Table 1 of this report for existing and proposed flows to the Point of Analysis, showing that Standard #2 is met.

Therefore Standard #2 is met.

Standard #3: Recharge to groundwater

Loss of annual recharge to groundwater shall be eliminated or minimized through the use of environmentally sensitive site design, stormwater best management practices, and good operation and maintenance procedures. At a minimum, the annual recharge from the post- development site shall approximate the annual recharge from pre-development conditions based on soil type. This Standard is met when the stormwater management system is designed to infiltrate the required recharge volume as determined in accordance with the Massachusetts Stormwater Handbook.

Soil types have been identified based on the information contained in the Soil Report (see Soil Report within appendices of this report). Based on the available soil information provided in the appendices of this report, we have determined that the soils are consistent with Hydrologic soil type “B” which require runoff to be infiltrated (as listed in the table below) from new impervious areas. Test pit data from testing done on site confirms the Soil Report information in the appendices of this report.

Hydrologic Group Volume to Recharge x (Total Impervious Area)	
Hydrologic Group	Volume to Recharge x Total Impervious Area
A	0.60 inches of runoff
B	0.35 inches of runoff
C	0.25 inches of runoff
D	0.10 inches of runoff

<u>“B” Soils</u>

Infiltration Rate: 0.35 inches of runoff
Existing Impervious Area: 7.78 Ac. (338,984 sf)
Proposed Impervious Area: 8.63 Ac. (375,923 sf)
Proposed Site New Impervious Area in “B” Soils: 36,939 sf
36,939 sf x 0.35 x (1/12) = 1,077 cf

Total required recharge volume: 1,077 cf

Proposed Recharge Volume:
Infiltration System UGS-1 = 2,498 cf

Total provided recharge volume: 2,498 cf

Drawdown Time:

UGS-1 (maximum time 72 hours)= 2,523 cf / (1.02 in/hr x 1,672 sf / 12 in/ft) = 17.75 hours

Therefore Standard #3 is met.

Standard #4: TSS removal

The BMP's selected to remove TSS from impervious areas for this include: Deep Sump Catch Basins (CB), Water Quality Units (WQU), three (3) bioretention areas & an Infiltration System (UGS-1). Building roof runoff is considered "clean" and therefore does not require TSS removal.

P-Watershed-1: (Parking, Walkways)
Deep Sump Catch Basin: (1.00)(1.00-0.25)= 0.75
Water Quality Unit: (0.75)(1.00-0.80)=0.15
Total TSS Removal= 85%

P-Watershed-1A: (Parking, Walkways)
Deep Sump Catch Basin: (1.00)(1.00-0.25)= 0.75
Water Quality Unit: (0.75)(1.00-0.80)=0.15
Total TSS Removal= 85%

P-Watershed-2: (Parking, Walkways)
Deep Sump Catch Basin: (1.00)(1.00-0.25)= 0.75
Infiltration Basin: (0.75)(1.00-0.80)=0.15
Total TSS Removal= 85%

P-Watershed-3A: (Parking, Walkways)
Deep Sump Catch Basin: (1.00)(1.00-0.25)= 0.75
Bioretention Area: (0.75)(1.00-0.90)=0.075
Bioretention Area: (0.08)(1.00-0.90)=0.008
Bioretention Area: (0.01)(1.00-0.90)=0.001
Total TSS Removal= 99.9%

P-Watershed-3B: (Parking)
Deep Sump Catch Basin: (1.00)(1.00-0.25)= 0.75
Bioretention Area: (0.75)(1.00-0.90)=0.075
Bioretention Area: (0.08)(1.00-0.90)=0.008
Total TSS Removal= 99%

Water Quality Volume:

The project qualifies for the 0.5" runoff rate applied to the total impervious area for the water quality volume, as shown in the calculations provided below. The calculations for the infiltration stormwater BMPs are shown below. Where site topography and groundwater elevation precluded the use of infiltration BMPs, proprietary water quality unit are proposed which are specifically designed to address water quality prior to discharge. Roof runoff is considered "clean" and has therefore been excluded from this calculation.

Impervious area requiring water quality treatment= 82,241 sf
82,241 sf * .0417 ft = 3,429 CF

Total Water Quality Volume Required = 3,429 CF

Proposed Water Quality Volume:
Infiltration System UGS-1 = 2,498 cf
Bioretention System RG-1 = 333 cf
Bioretention System RG-2 = 609 cf
Bioretention System RG-3 = 890 cf

Total provided water quality volume: 4,330 cf

Therefore Standard #4 is met.

Standard #5: Higher potential pollutant loads

The project site does not contain Land Uses with Higher Potential Pollutant Loads, therefore Standard #5 is met.

Standard #6: Protection of critical areas

Critical areas are Outstanding Resource Waters (ORW) as designated in 314 CMR 4.00, Special Resource Waters as designated in 314 CMR 4.00, recharge areas for public water supplies as defined in 310 CMR 22.02 (Zone Is, Zone IIs and Interim Wellhead Protection Areas for groundwater sources and Zone As for surface water sources), bathing beaches as defined in 105 CMR 445.000, cold-water fisheries as defined in 314 CMR 9.02 and 310 CMR 10.04, and shellfish growing areas as defined in 314 CMR 9.02 and 310 CMR 10.04.

The site is not located within critical areas, therefore Standard #6 is met.

Standard #7: Redevelopment projects

While a portion of the site is being redeveloped, there is an increase in impervious area, thus the project is considered New Construction and all of the Standards will be met.

Standard #8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

Soil Erosion and Sediment Control Plan:
The objectives of the Soil Erosion and Sediment Control Plan are to control erosion at its source with temporary control structures, minimize the runoff from areas of disturbance, and de-concentrate and distribute stormwater runoff through natural vegetation before discharge to critical zones such as streams or wetlands. Soil erosion control does not begin with the perimeter sediment trap. It begins at the source of the sediment, the disturbed land areas, and extends down to the control structure.

The Soil Erosion and Sediment Control Plan will be enacted in order to protect the resource areas during construction. The erosion control devices will remain in place until all exposed areas have been stabilized with vegetation or impervious surfaces.

The objective of the Soil Erosion & Sediment Control Plan that will be enacted on site is to control the vulnerability of the soil to the erosion process or the capability of moving water to detach soil particles during the construction phase(s).

The soil erosion and sediment control BMP's for the site are straw wattles with silt fence, catch basin filters, and a construction entrance as shown on design plans prepared by Samiotes Consultants, Inc.

Therefore Standard #8 is met.

Standard #9: Operation/maintenance plan

An operation and maintenance plan for both construction and post-development stormwater controls has been developed. The plan includes owner(s); parties responsible for operation and maintenance; schedule for inspection and maintenance; routine and non-routine maintenance tasks. A copy of the O&M is included in the appendices of this report.

Therefore Standard #9 is met.

Standard #10: All illicit discharges to the stormwater management system are prohibited

It is not anticipated that there will be any Illicit discharges for the project as it will be new construction, therefore Standard #10 is met.

P:\Projects\2017\17211.00 Arlington HS, 869 Mass Ave (Civil)\Documents\Hydrology

Checklist for Stormwater Report

A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.

A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals.[1] This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8[2]
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

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[1] The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

[2] For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Registered Professional Engineer Block and Signature

COMMONWEALTH OF MASSACHUSETTS
STEPHEN R. GARVIN
CIVIL
NO.42772
REGISTERED
PROFESSIONAL ENGINEER

5/7/20

Signature and Date

Checklist

Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?

☐ New development

☐ Redevelopment

☒ Mix of New Development and Redevelopment

Checklist (continued)

LID Measures: Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

- ☒ No disturbance to any Wetland Resource Areas
- ☐ Site Design Practices (e.g. clustered development, reduced frontage setbacks)
- ☐ Reduced Impervious Area (Redevelopment Only)
- ☐ Minimizing disturbance to existing trees and shrubs
- ☐ LID Site Design Credit Requested:
  - ☐ Credit 1
  - ☐ Credit 2
  - ☐ Credit 3
- ☐ Use of “country drainage” versus curb and gutter conveyance and pipe
- ☒ Bioretention Cells (includes Rain Gardens)
- ☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
- ☐ Treebox Filter
- ☐ Water Quality Swale
- ☐ Grass Channel
- ☐ Green Roof
- ☐ Other (describe): ______

Standard 1: No New Untreated Discharges

- ☒ No new untreated discharges
- ☒ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
- ☒ Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist (continued)

Standard 2: Peak Rate Attenuation

☐ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.

☐ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.

☒ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

☐ Required Recharge volume reduced through use of the LID site Design Credits.

☒ Sizing the infiltration, BMPs is based on the following method: Check the method used.

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

☐ Runoff from all impervious areas at the site discharging to the infiltration BMP.

☒ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.

☒ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:

- ☐ Site is comprised solely of C and D soils and/or bedrock at the land surface
- ☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
- ☐ Solid Waste Landfill pursuant to 310 CMR 19.000
- ☐ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

☒ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.

☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

[1] 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

Checklist (continued)

Standard 3: Recharge (continued)

☐ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.

☐ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

The Long-Term Pollution Prevention Plan typically includes the following:
- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.

☒ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.

☐ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:

- ☐ is within the Zone II or Interim Wellhead Protection Area
- ☐ is near or to other critical areas
- ☐ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
- ☐ involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

☒ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

☒ The BMP is sized (and calculations provided) based on:

- ☒ The ½" or 1" Water Quality Volume or
- ☐ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.

☒ The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.

☐ A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)

☐ The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.

☒ The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted ***prior to*** the discharge of stormwater to the post-construction stormwater BMPs.

☐ The NPDES Multi-Sector General Permit does ***not*** cover the land use.

☐ LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.

☐ All exposure has been eliminated.

☐ All exposure has ***not*** been eliminated and all BMPs selected are on MassDEP LUHPPL list.

☐ The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas

☐ The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.

☐ Critical areas and BMPs are identified in the Stormwater Report.

Checklist (continued)

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable

☒ The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:

- ☐ Limited Project
- ☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
- ☐ Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
- ☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
- ☐ Bike Path and/or Foot Path
- ☐ Redevelopment Project
- ☒ Redevelopment portion of mix of new and redevelopment.

☐ Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.

☐ The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.

☒ A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.

Checklist (continued)

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control (continued)

☐ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has ***not*** been included in the Stormwater Report but will be submitted ***before*** land disturbance begins.

☐ The project is ***not*** covered by a NPDES Construction General Permit.

☐ The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.

☒ The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

☒ The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:

- ☒ Name of the stormwater management system owners;
- ☒ Party responsible for operation and maintenance;
- ☒ Schedule for implementation of routine and non-routine maintenance tasks;
- ☒ Plan showing the location of all stormwater BMPs maintenance access areas;
- ☐ Description and delineation of public safety features;
- ☐ Estimated operation and maintenance budget; and
- ☒ Operation and Maintenance Log Form.

☐ The responsible party is ***not*** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:

- ☐ A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
- ☐ A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

Standard 10: Prohibition of Illicit Discharges

☐ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

☐ An Illicit Discharge Compliance Statement is attached;

☒ NO Illicit Discharge Compliance Statement is attached but will be submitted ***prior to*** the discharge of any stormwater to post-construction BMPs.

APPENDIX 1:
Existing Hydrology Calculations

APPENDIX 2:
Proposed Hydrology Calculations

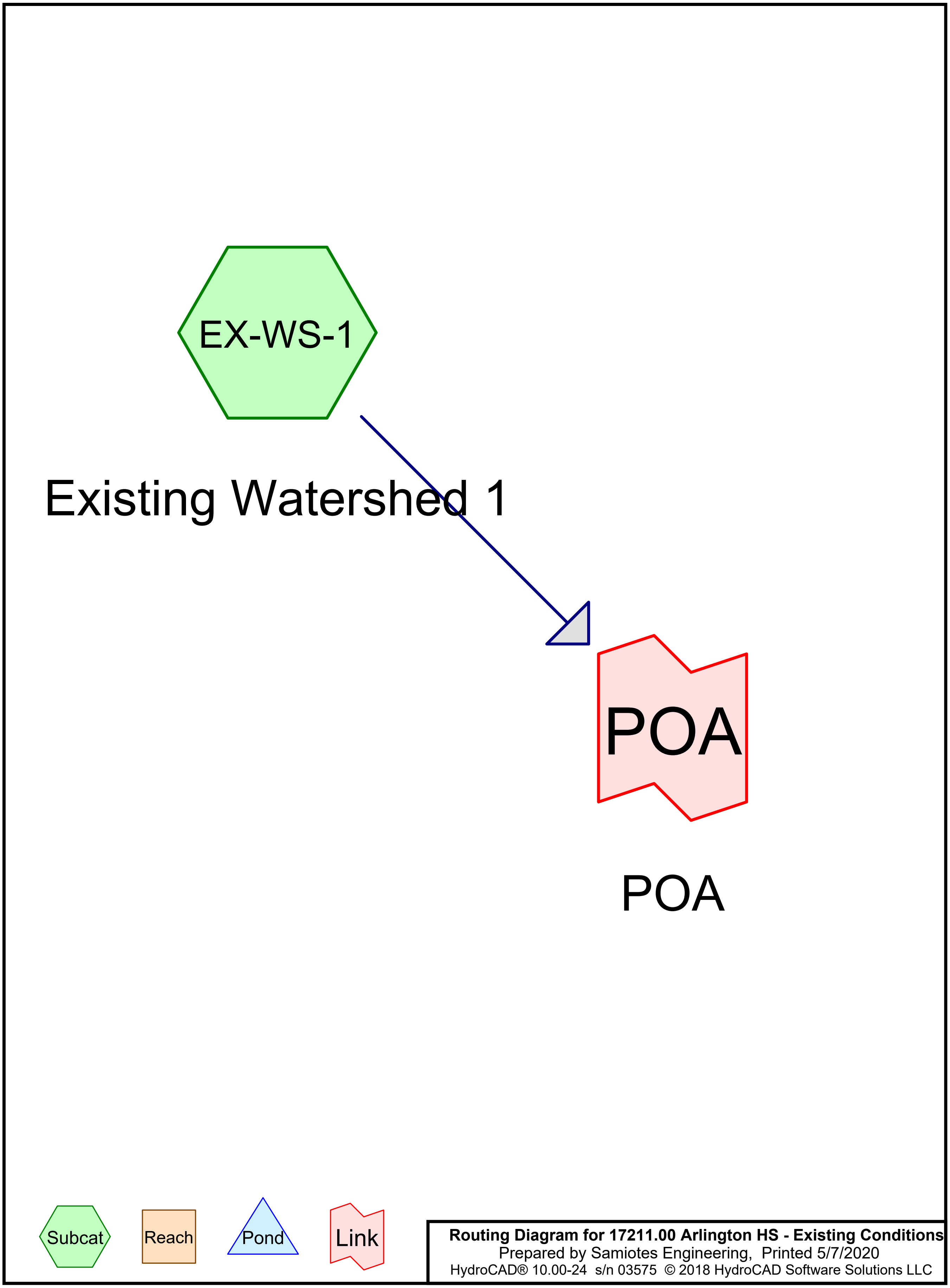
APPENDIX 3:
Test Pit Logs
Soils Report

APPENDIX 4:
Operations and Maintenance Plan

APPENDIX 5:
Calculations

APPENDIX 6:
Sketches

APPENDIX 1:
Existing Hydrology Calculations



Routing Diagram for 17211.00 Arlington HS - Existing Conditions
Prepared by Samiotes Engineering, Printed 5/7/2020

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
9.598	61	>75% Grass cover, Good, HSG B (EX-WS-1)
5.051	98	Impervious (EX-WS-1)
2.731	98	Roofs, HSG B (EX-WS-1)
0.020	55	Woods, Good, HSG B (EX-WS-1)
17.400	**78**	**TOTAL AREA**

Summary for Subcatchment EX-WS-1: Existing Watershed 1

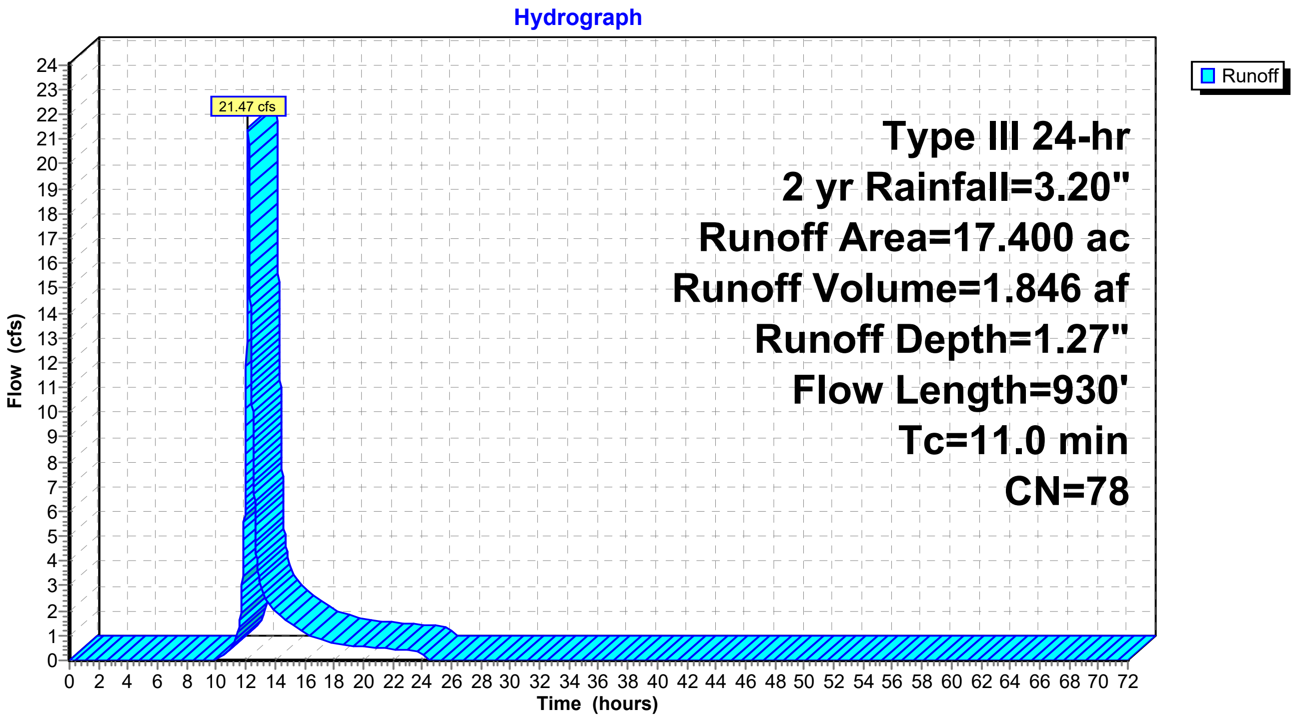
Runoff = 21.47 cfs @ 12.16 hrs, Volume= 1.846 af, Depth= 1.27"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2 yr Rainfall=3.20"

	Area (ac)	CN	Description
*	5.051	98	Impervious
	2.731	98	Roofs, HSG B
	9.598	61	>75% Grass cover, Good, HSG B
	0.020	55	Woods, Good, HSG B
	17.400	78	Weighted Average
	9.618		55.28% Pervious Area
	7.782		44.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.4	50	0.0100	0.11		**Sheet Flow, 50' SF** Grass: Short n= 0.150 P2= 3.20"
1.9	220	0.0140	1.90		**Shallow Concentrated Flow, 220' SCF** Unpaved Kv= 16.1 fps
0.9	140	0.0150	2.49		**Shallow Concentrated Flow, 140' SCF (paved)** Paved Kv= 20.3 fps
0.1	20	0.0100	4.91	3.86	**Pipe Channel, 12" Pipe Flow** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012
0.7	500	0.0050	11.67	466.77	**Pipe Channel, Box Culvert Flow** 96.0" x 60.0" Box Area= 40.0 sf Perim= 26.0' r= 1.54' n= 0.012
11.0	930	Total			

Subcatchment EX-WS-1: Existing Watershed 1

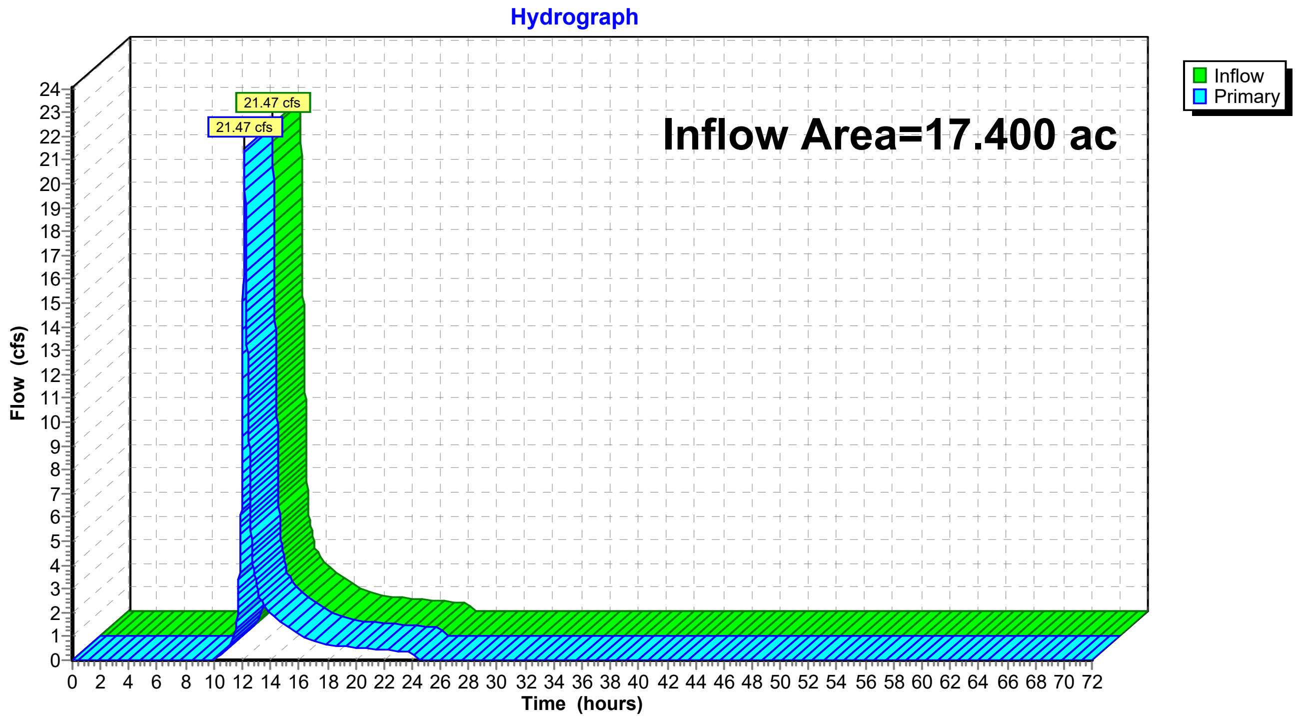


Summary for Link POA: POA

Inflow Area = 17.400 ac, 44.72% Impervious, Inflow Depth = 1.27" for 2 yr event
Inflow = 21.47 cfs @ 12.16 hrs, Volume= 1.846 af
Primary = 21.47 cfs @ 12.16 hrs, Volume= 1.846 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link POA: POA



Summary for Subcatchment EX-WS-1: Existing Watershed 1

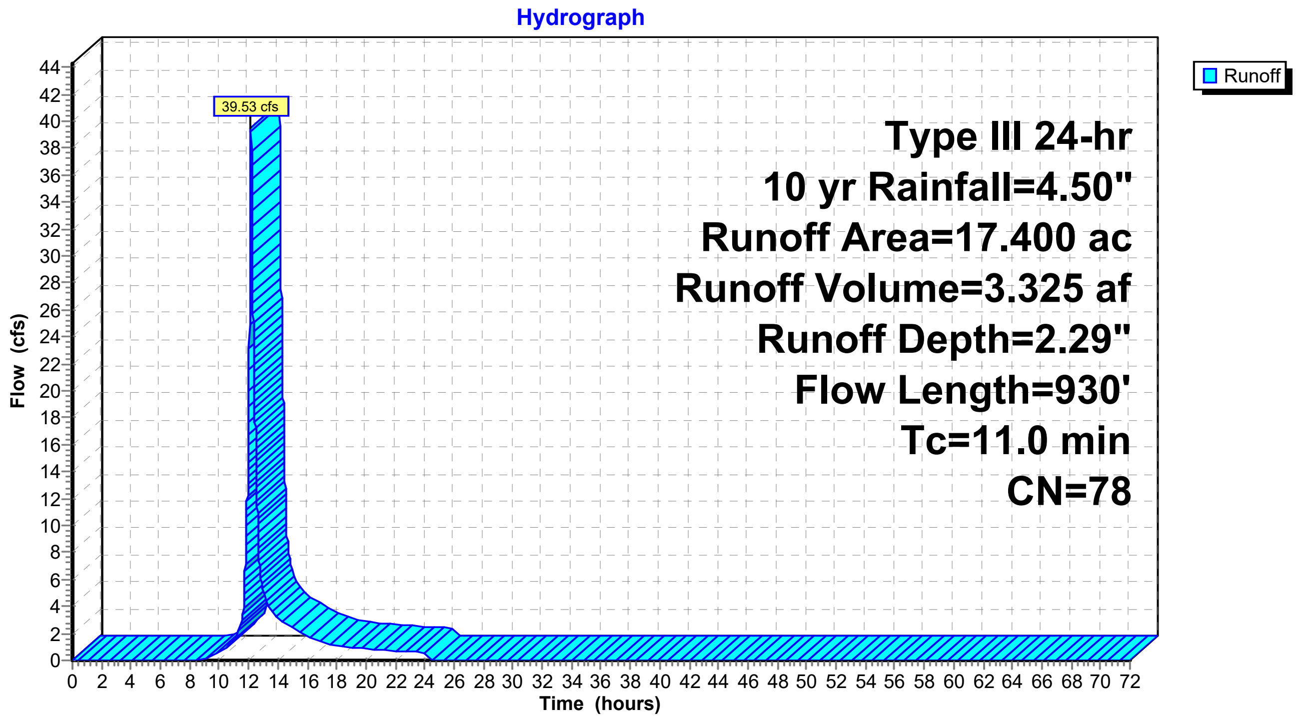
Runoff = 39.53 cfs @ 12.16 hrs, Volume= 3.325 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 yr Rainfall=4.50"

	Area (ac)	CN	Description
*	5.051	98	Impervious
	2.731	98	Roofs, HSG B
	9.598	61	>75% Grass cover, Good, HSG B
	0.020	55	Woods, Good, HSG B
	17.400	78	Weighted Average
	9.618		55.28% Pervious Area
	7.782		44.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.4	50	0.0100	0.11		**Sheet Flow, 50' SF** Grass: Short n= 0.150 P2= 3.20"
1.9	220	0.0140	1.90		**Shallow Concentrated Flow, 220' SCF** Unpaved Kv= 16.1 fps
0.9	140	0.0150	2.49		**Shallow Concentrated Flow, 140' SCF (paved)** Paved Kv= 20.3 fps
0.1	20	0.0100	4.91	3.86	**Pipe Channel, 12" Pipe Flow** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012
0.7	500	0.0050	11.67	466.77	**Pipe Channel, Box Culvert Flow** 96.0" x 60.0" Box Area= 40.0 sf Perim= 26.0' r= 1.54' n= 0.012
11.0	930	Total			

Subcatchment EX-WS-1: Existing Watershed 1

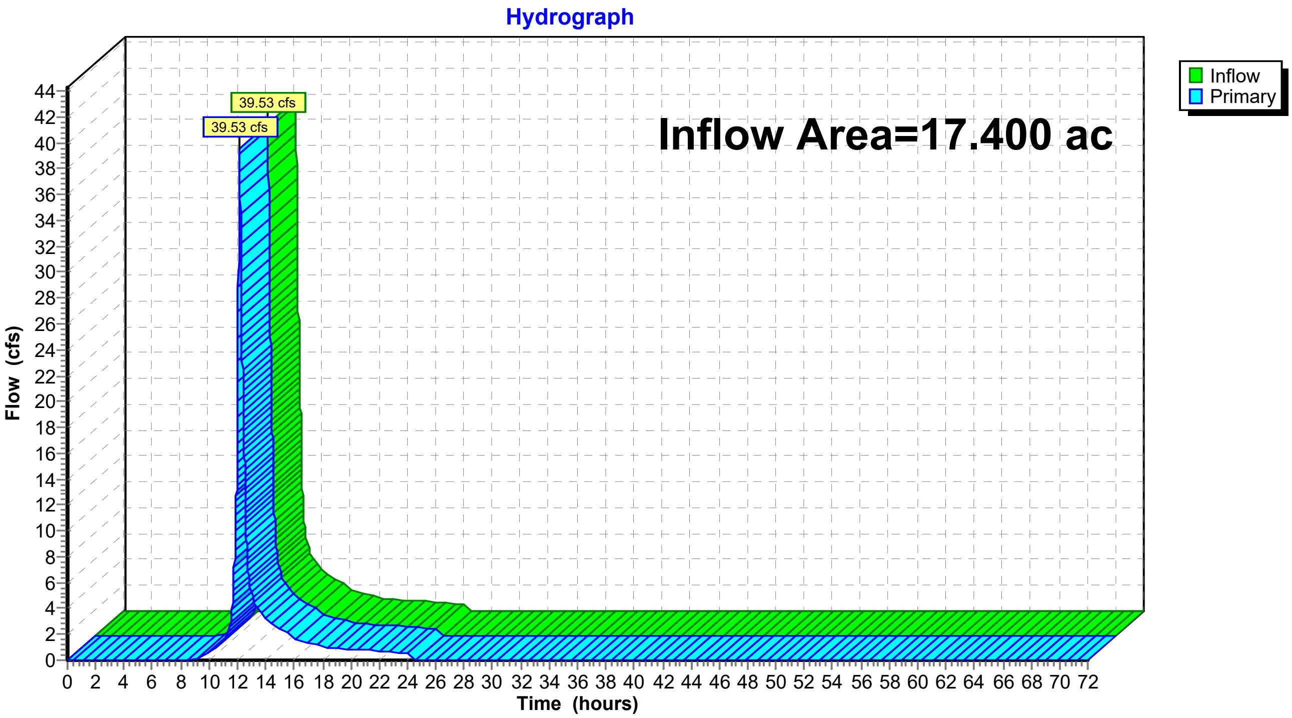


Summary for Link POA: POA

Inflow Area = 17.400 ac, 44.72% Impervious, Inflow Depth = 2.29" for 10 yr event
Inflow = 39.53 cfs @ 12.16 hrs, Volume= 3.325 af
Primary = 39.53 cfs @ 12.16 hrs, Volume= 3.325 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link POA: POA



Summary for Subcatchment EX-WS-1: Existing Watershed 1

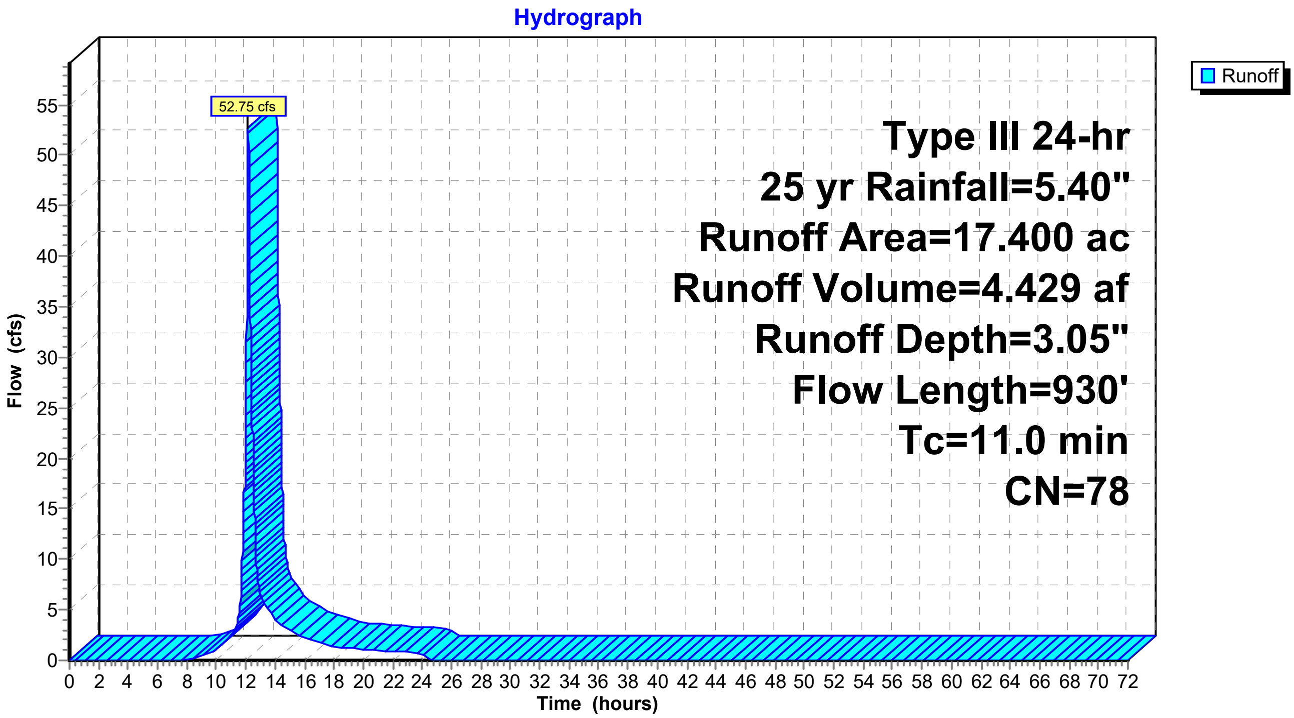
Runoff = 52.75 cfs @ 12.15 hrs, Volume= 4.429 af, Depth= 3.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25 yr Rainfall=5.40"

	Area (ac)	CN	Description
*	5.051	98	Impervious
	2.731	98	Roofs, HSG B
	9.598	61	>75% Grass cover, Good, HSG B
	0.020	55	Woods, Good, HSG B
	17.400	78	Weighted Average
	9.618		55.28% Pervious Area
	7.782		44.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.4	50	0.0100	0.11		**Sheet Flow, 50' SF** Grass: Short n= 0.150 P2= 3.20"
1.9	220	0.0140	1.90		**Shallow Concentrated Flow, 220' SCF** Unpaved Kv= 16.1 fps
0.9	140	0.0150	2.49		**Shallow Concentrated Flow, 140' SCF (paved)** Paved Kv= 20.3 fps
0.1	20	0.0100	4.91	3.86	**Pipe Channel, 12" Pipe Flow** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012
0.7	500	0.0050	11.67	466.77	**Pipe Channel, Box Culvert Flow** 96.0" x 60.0" Box Area= 40.0 sf Perim= 26.0' r= 1.54' n= 0.012
11.0	930	Total			

Subcatchment EX-WS-1: Existing Watershed 1

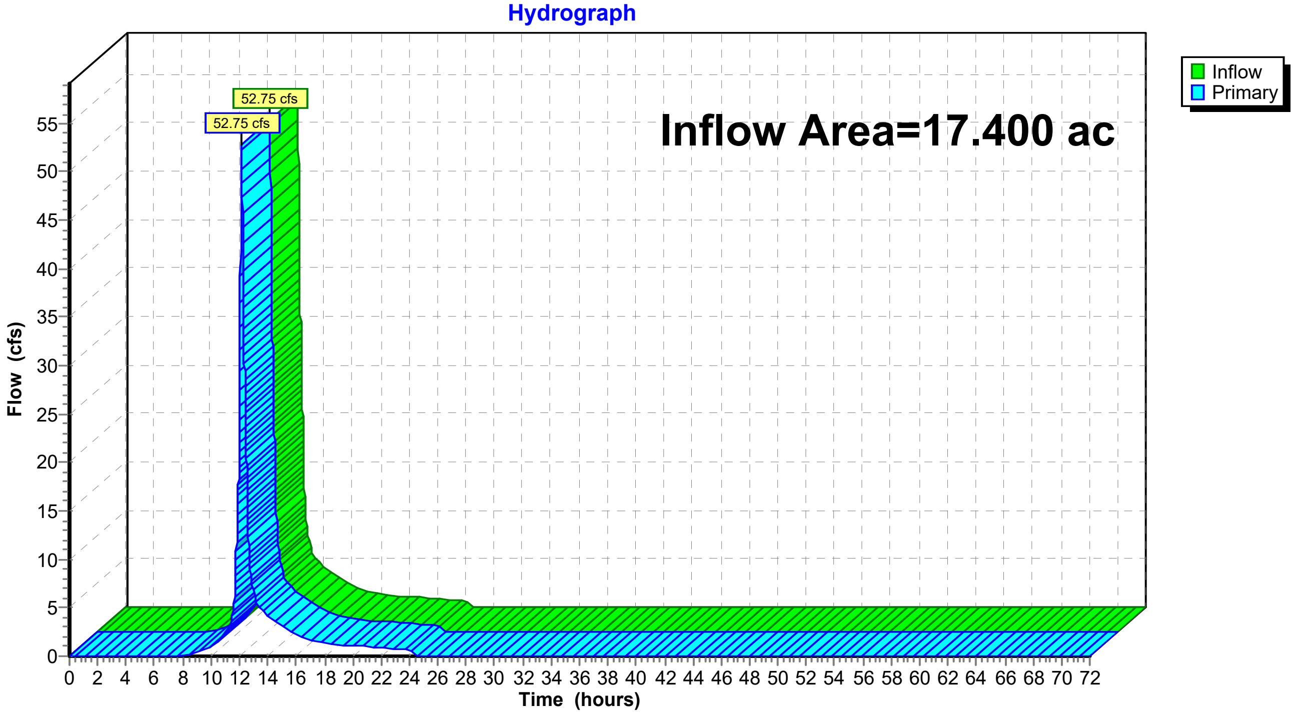


Summary for Link POA: POA

Inflow Area = 17.400 ac, 44.72% Impervious, Inflow Depth = 3.05" for 25 yr event
Inflow = 52.75 cfs @ 12.15 hrs, Volume= 4.429 af
Primary = 52.75 cfs @ 12.15 hrs, Volume= 4.429 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link POA: POA



Summary for Subcatchment EX-WS-1: Existing Watershed 1

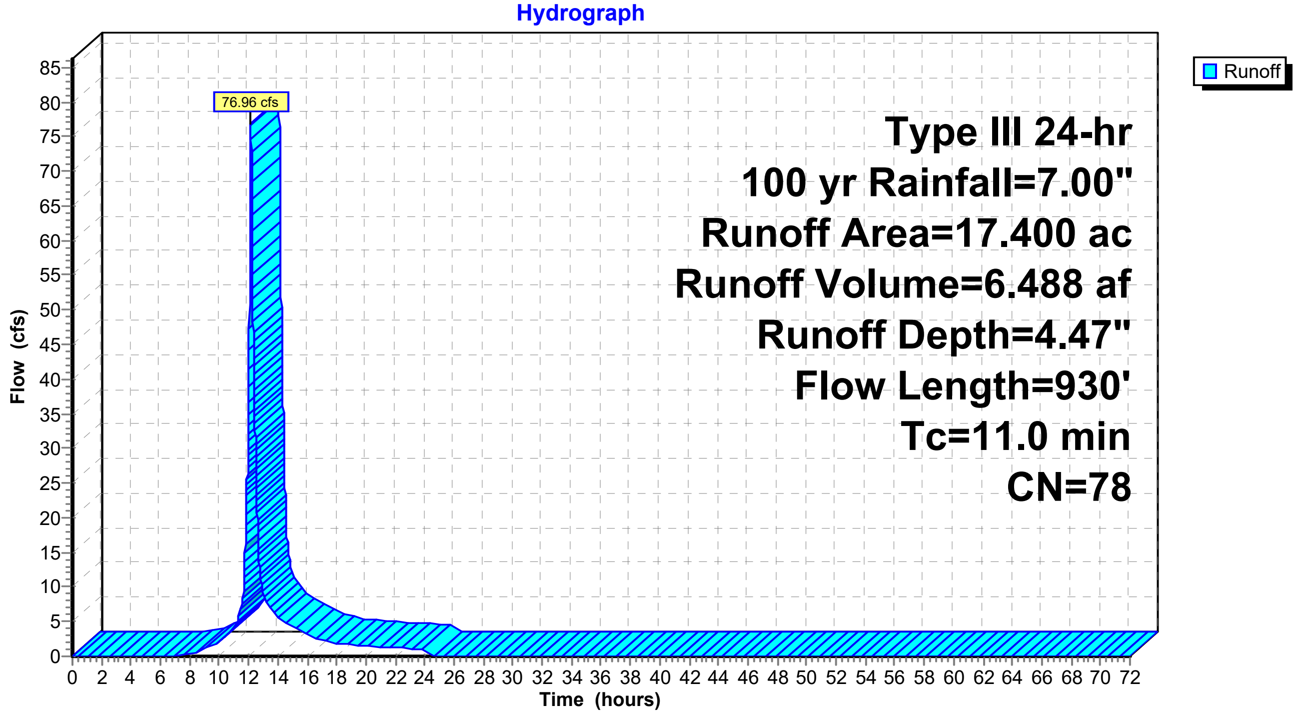
Runoff = 76.96 cfs @ 12.15 hrs, Volume= 6.488 af, Depth= 4.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 yr Rainfall=7.00"

	Area (ac)	CN	Description
*	5.051	98	Impervious
	2.731	98	Roofs, HSG B
	9.598	61	>75% Grass cover, Good, HSG B
	0.020	55	Woods, Good, HSG B
	17.400	78	Weighted Average
	9.618		55.28% Pervious Area
	7.782		44.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.4	50	0.0100	0.11		**Sheet Flow, 50' SF** Grass: Short n= 0.150 P2= 3.20"
1.9	220	0.0140	1.90		**Shallow Concentrated Flow, 220' SCF** Unpaved Kv= 16.1 fps
0.9	140	0.0150	2.49		**Shallow Concentrated Flow, 140' SCF (paved)** Paved Kv= 20.3 fps
0.1	20	0.0100	4.91	3.86	**Pipe Channel, 12" Pipe Flow** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012
0.7	500	0.0050	11.67	466.77	**Pipe Channel, Box Culvert Flow** 96.0" x 60.0" Box Area= 40.0 sf Perim= 26.0' r= 1.54' n= 0.012
11.0	930	Total			

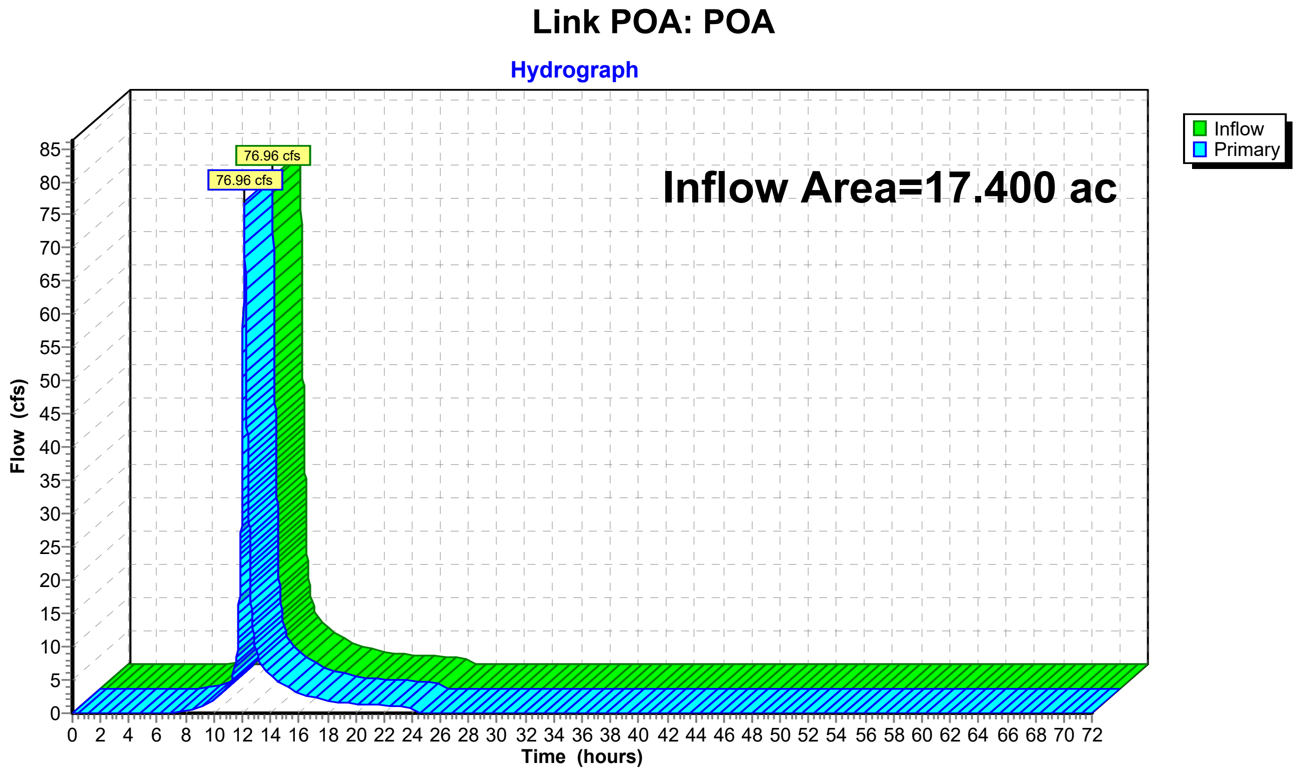
Subcatchment EX-WS-1: Existing Watershed 1



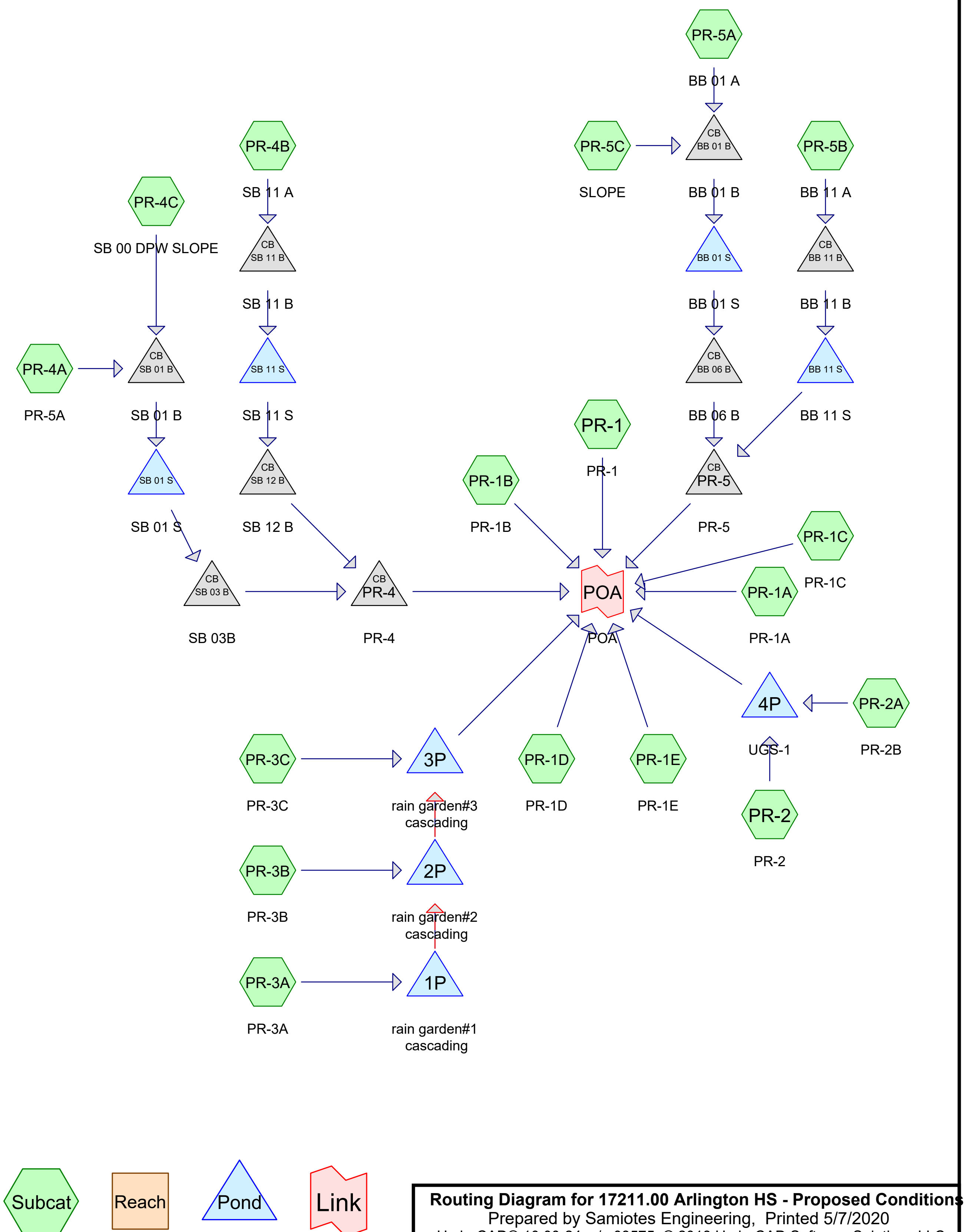
Summary for Link POA: POA

Inflow Area = 17.400 ac, 44.72% Impervious, Inflow Depth = 4.47" for 100 yr event
Inflow = 76.96 cfs @ 12.15 hrs, Volume= 6.488 af
Primary = 76.96 cfs @ 12.15 hrs, Volume= 6.488 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs



APPENDIX 2:
Proposed Hydrology Calculations



Routing Diagram for 17211.00 Arlington HS - Proposed Conditions
Prepared by Samiotes Engineering, Printed 5/7/2020
HydroCAD® 10.00-24 s/n 03575 © 2018 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
4.695	61	>75% Grass cover, Good, HSG B (PR-1, PR-1A, PR-1C, PR-1E, PR-2, PR-3A, PR-3B, PR-3C, PR-4C, PR-5C)
4.964	98	Paved parking, HSG B (PR-1, PR-1A, PR-1C, PR-1E, PR-2, PR-3A, PR-3B)
3.627	98	Roofs, HSG B (PR-1B, PR-1D, PR-2A)
4.056	85	SYNTHETIC TURF- PAD- LINER (PR-4A, PR-4B, PR-5A, PR-5B)
0.025	98	Unconnected pavement, HSG B (PR-4C)
0.014	98	Unconnected roofs, HSG B (PR-5C)
0.020	55	Woods, Good, HSG B (PR-1C)
17.400	**85**	**TOTAL AREA**

Summary for Subcatchment PR-1: PR-1

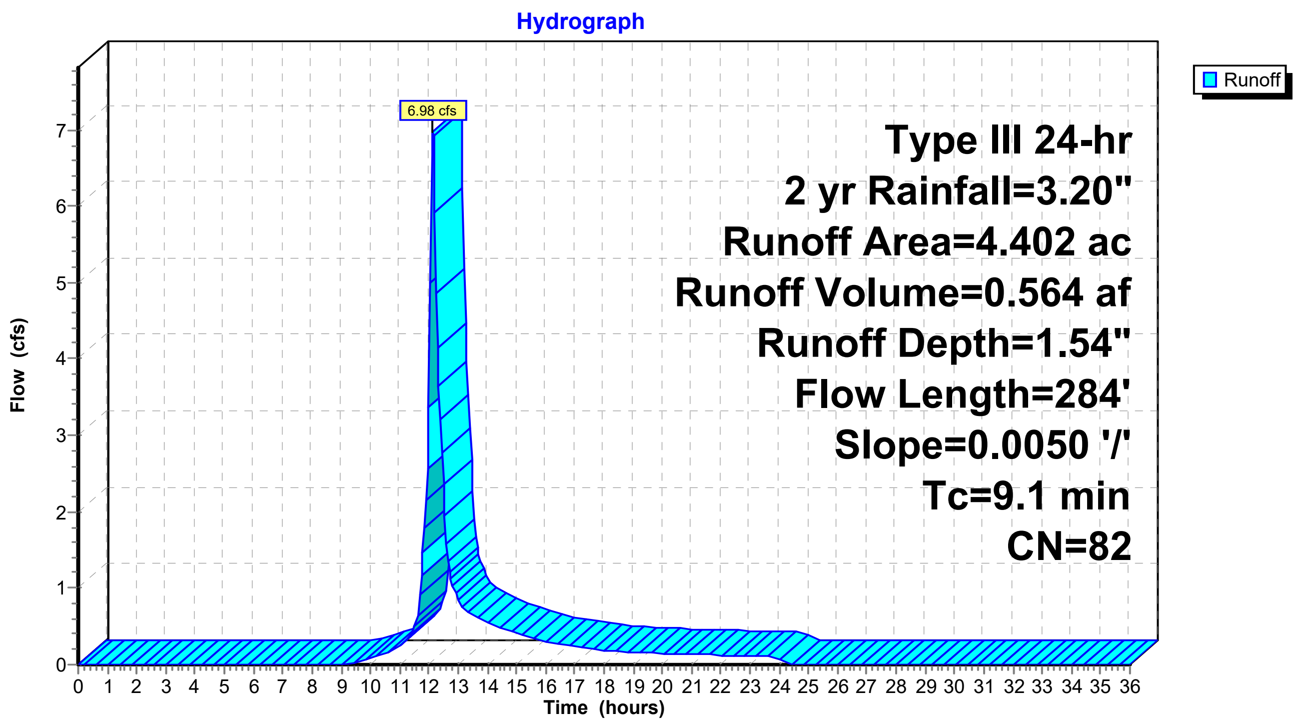
Runoff = 6.98 cfs @ 12.13 hrs, Volume= 0.564 af, Depth= 1.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.20"

Area (ac)	CN	Description
1.892	61	>75% Grass cover, Good, HSG B
2.510	98	Paved parking, HSG B
4.402	82	Weighted Average
1.892		42.98% Pervious Area
2.510		57.02% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	50	0.0050	0.69		**Sheet Flow, A-B** Smooth surfaces n= 0.011 P2= 3.20"
7.9	234	0.0050	0.49		**Shallow Concentrated Flow, B-C** Short Grass Pasture Kv= 7.0 fps
9.1	284	Total			

Subcatchment PR-1: PR-1



Summary for Subcatchment PR-1A: PR-1A

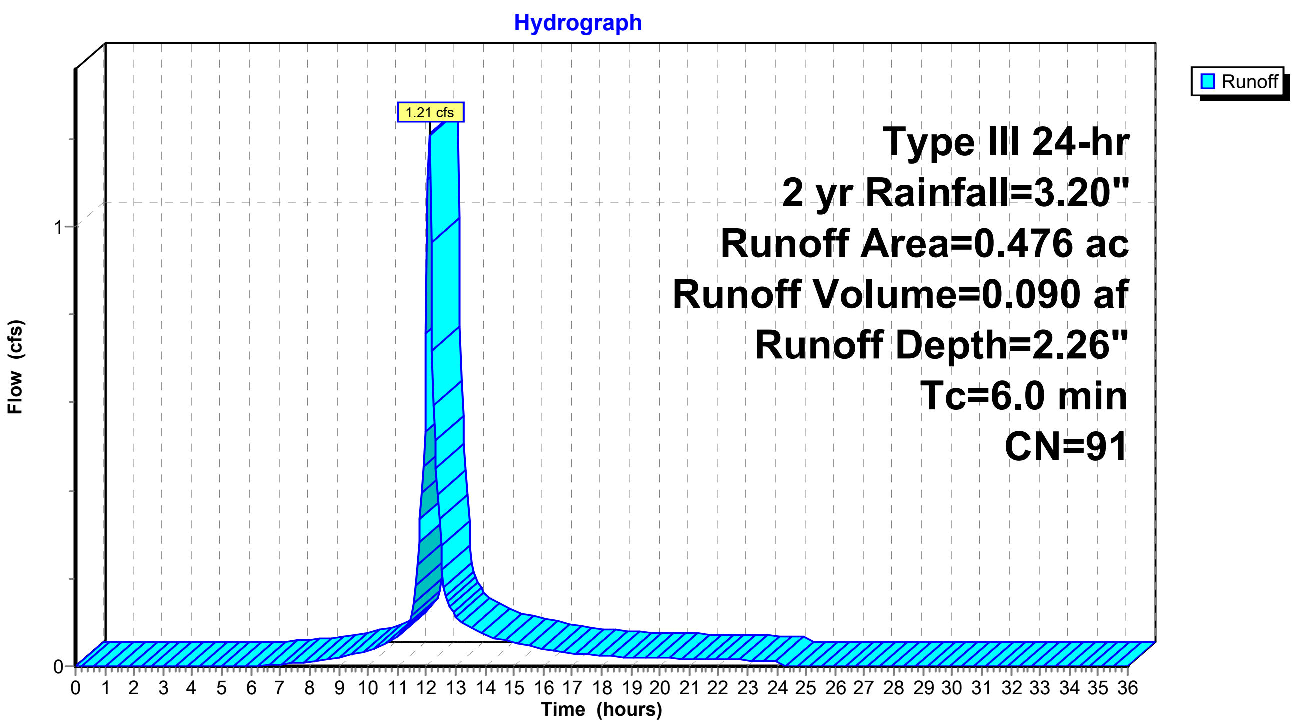
Runoff = 1.21 cfs @ 12.09 hrs, Volume= 0.090 af, Depth= 2.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.20"

Area (ac)	CN	Description
0.090	61	>75% Grass cover, Good, HSG B
0.386	98	Paved parking, HSG B
0.476	91	Weighted Average
0.090		18.91% Pervious Area
0.386		81.09% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-1A: PR-1A



Summary for Subcatchment PR-1B: PR-1B

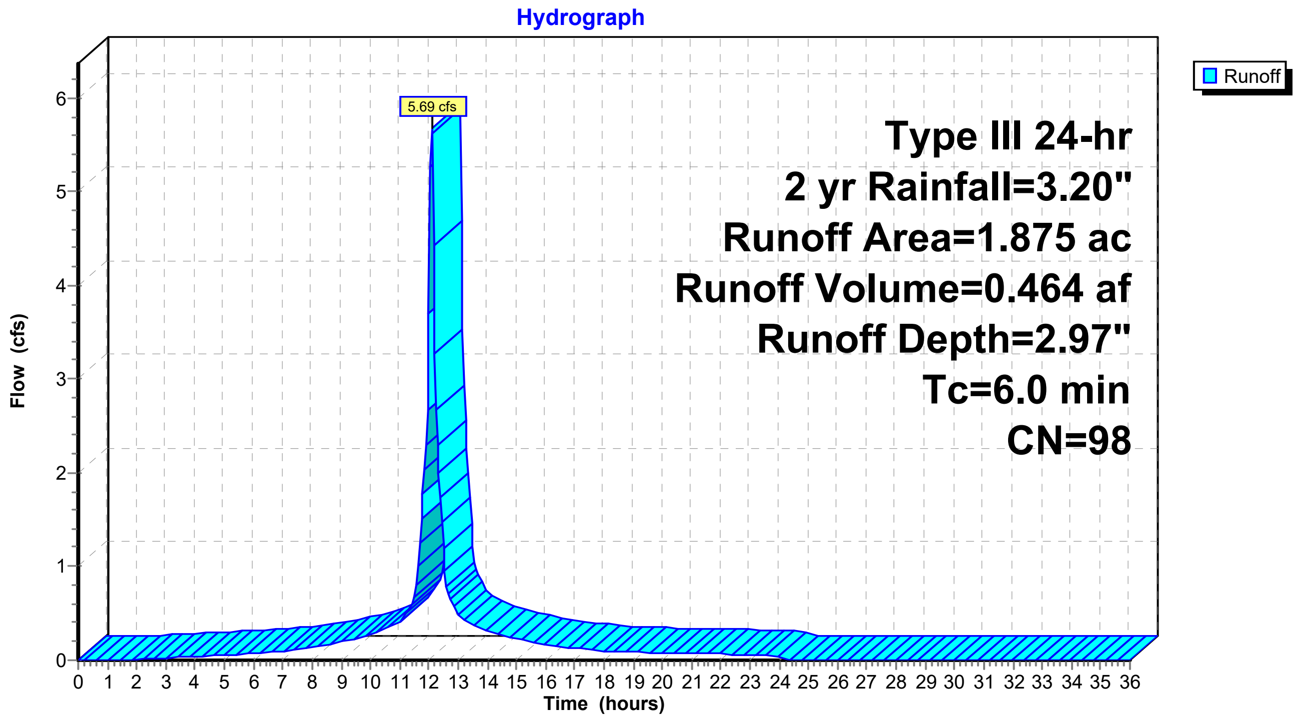
Runoff = 5.69 cfs @ 12.09 hrs, Volume= 0.464 af, Depth= 2.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.20"

Area (ac)	CN	Description
1.875	98	Roofs, HSG B
1.875		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-1B: PR-1B



Summary for Subcatchment PR-1C: PR-1C

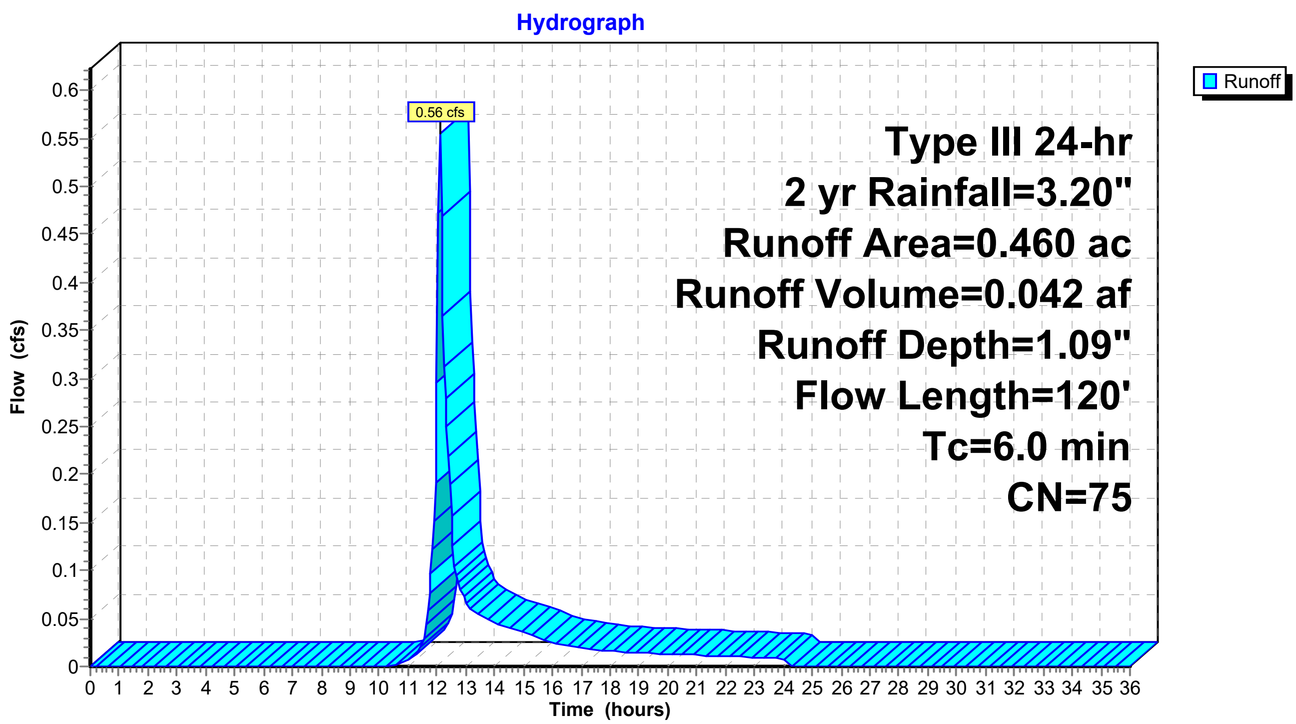
Runoff = 0.56 cfs @ 12.10 hrs, Volume= 0.042 af, Depth= 1.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.20"

Area (ac)	CN	Description
0.020	55	Woods, Good, HSG B
0.260	61	>75% Grass cover, Good, HSG B
0.180	98	Paved parking, HSG B
0.460	75	Weighted Average
0.280		60.87% Pervious Area
0.180		39.13% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	20	0.0700	0.09		**Sheet Flow, 20' SF** Woods: Light underbrush n= 0.400 P2= 3.20"
1.9	40	0.5000	0.35		**Sheet Flow, 30' SF** Grass: Dense n= 0.240 P2= 3.20"
0.1	12	0.0100	1.61		**Shallow Concentrated Flow, 12' SCF** Unpaved Kv= 16.1 fps
0.2	48	0.0400	4.06		**Shallow Concentrated Flow, 48' SCF** Paved Kv= 20.3 fps
5.8	120	Total, Increased to minimum Tc = 6.0 min			

Subcatchment PR-1C: PR-1C



Summary for Subcatchment PR-1D: PR-1D

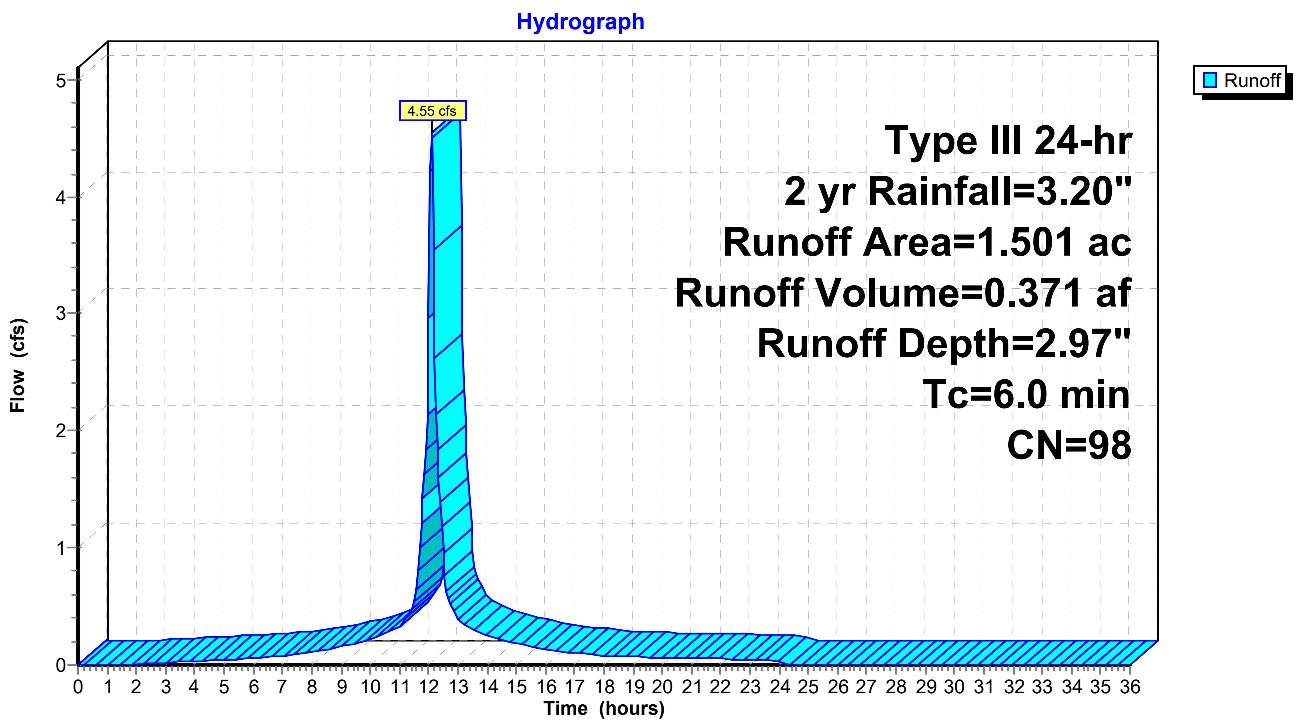
Runoff = 4.55 cfs @ 12.09 hrs, Volume= 0.371 af, Depth= 2.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.20"

Area (ac)	CN	Description
1.501	98	Roofs, HSG B
1.501		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-1D: PR-1D



Summary for Subcatchment PR-1E: PR-1E

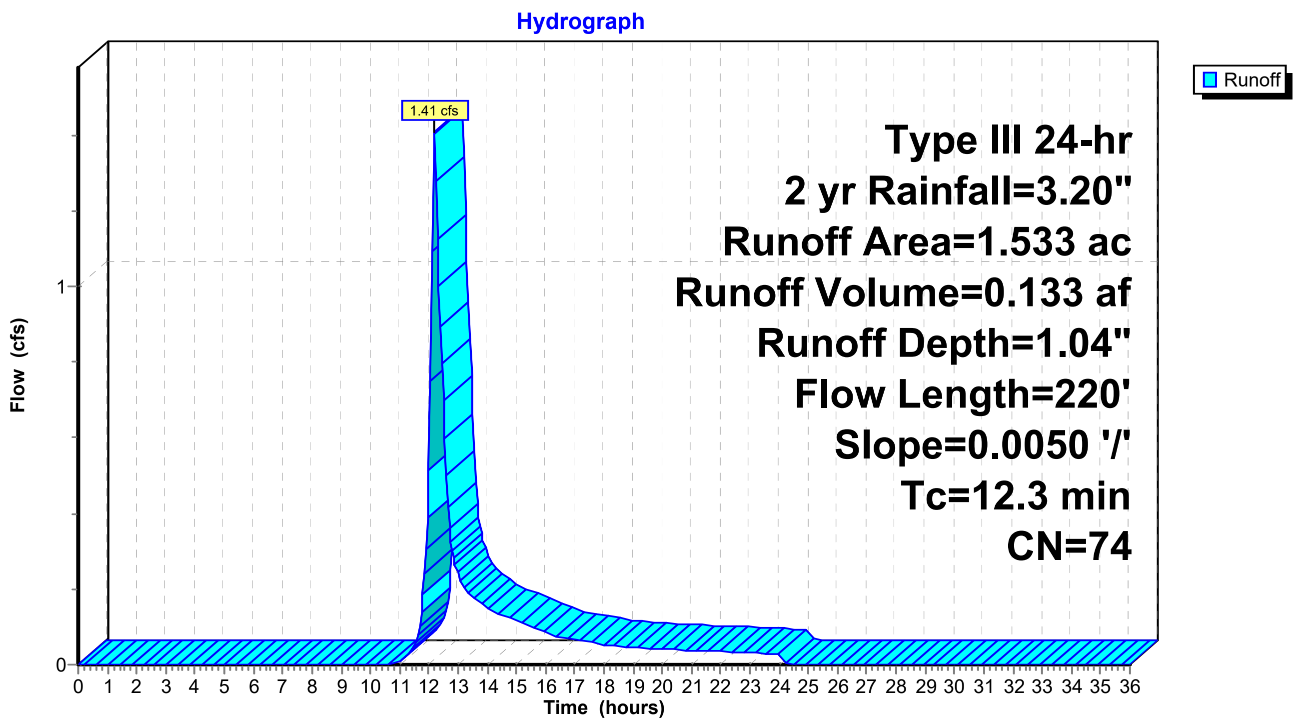
Runoff = 1.41 cfs @ 12.19 hrs, Volume= 0.133 af, Depth= 1.04"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.20"

Area (ac)	CN	Description
1.000	61	>75% Grass cover, Good, HSG B
0.533	98	Paved parking, HSG B
1.533	74	Weighted Average
1.000		65.23% Pervious Area
0.533		34.77% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.8	50	0.0050	0.09		**Sheet Flow, 50' SF** Grass: Short n= 0.150 P2= 3.20"
2.5	170	0.0050	1.14		**Shallow Concentrated Flow, 170' SCF** Unpaved Kv= 16.1 fps
12.3	220	Total			

Subcatchment PR-1E: PR-1E



Summary for Subcatchment PR-2: PR-2

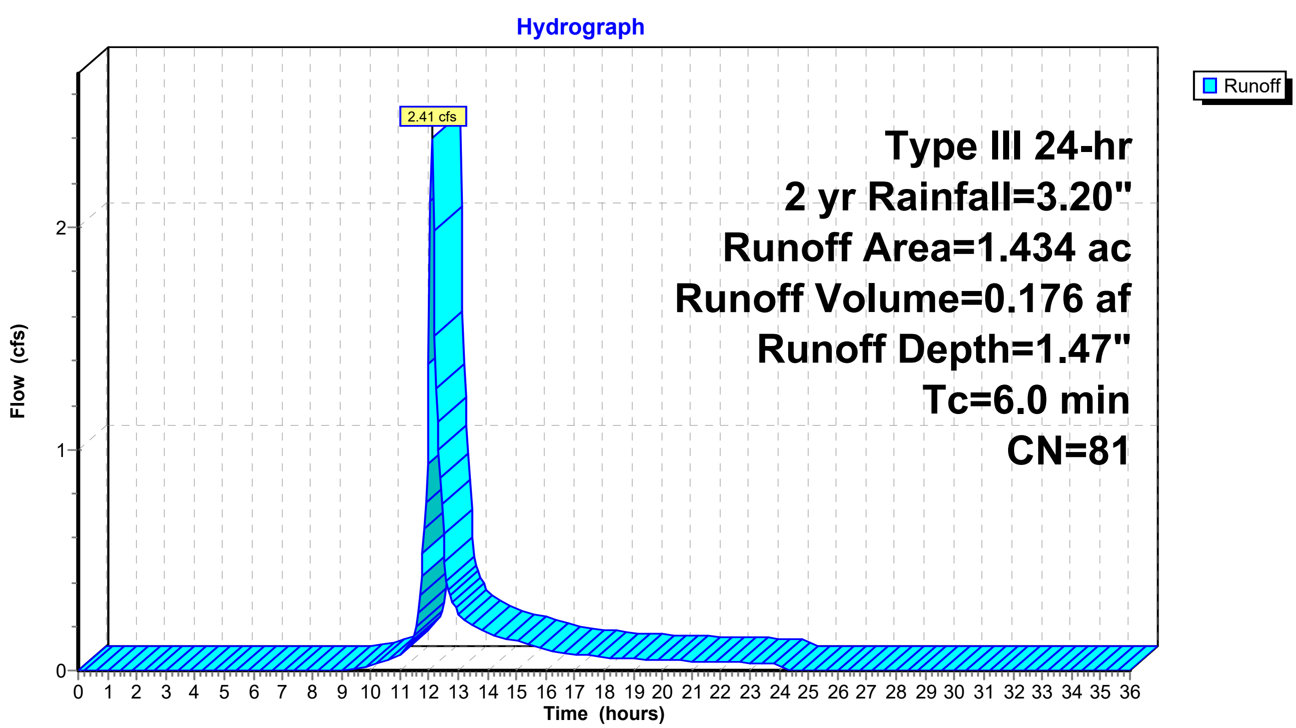
Runoff = 2.41 cfs @ 12.10 hrs, Volume= 0.176 af, Depth= 1.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.20"

Area (ac)	CN	Description
0.672	61	>75% Grass cover, Good, HSG B
0.762	98	Paved parking, HSG B
1.434	81	Weighted Average
0.672		46.86% Pervious Area
0.762		53.14% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-2: PR-2



Summary for Subcatchment PR-2A: PR-2B

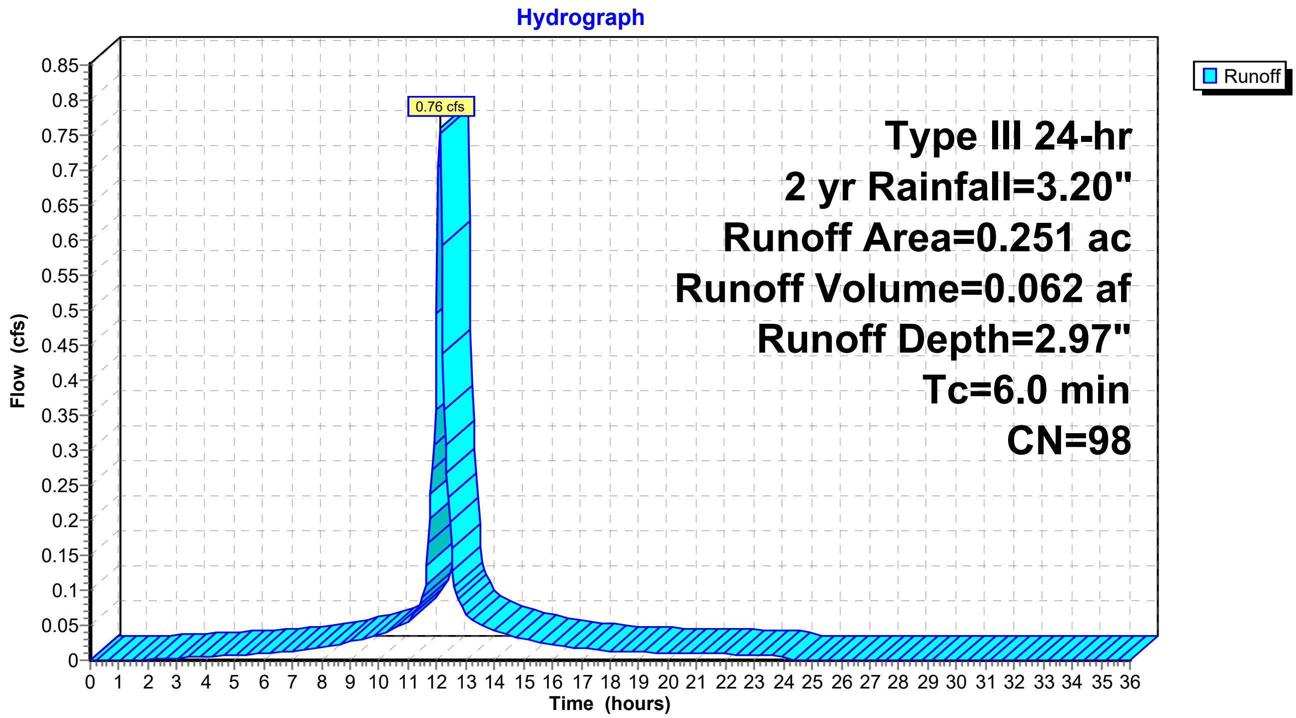
Runoff = 0.76 cfs @ 12.09 hrs, Volume= 0.062 af, Depth= 2.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.20"

Area (ac)	CN	Description
0.251	98	Roofs, HSG B
0.251		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-2A: PR-2B



Summary for Subcatchment PR-3A: PR-3A

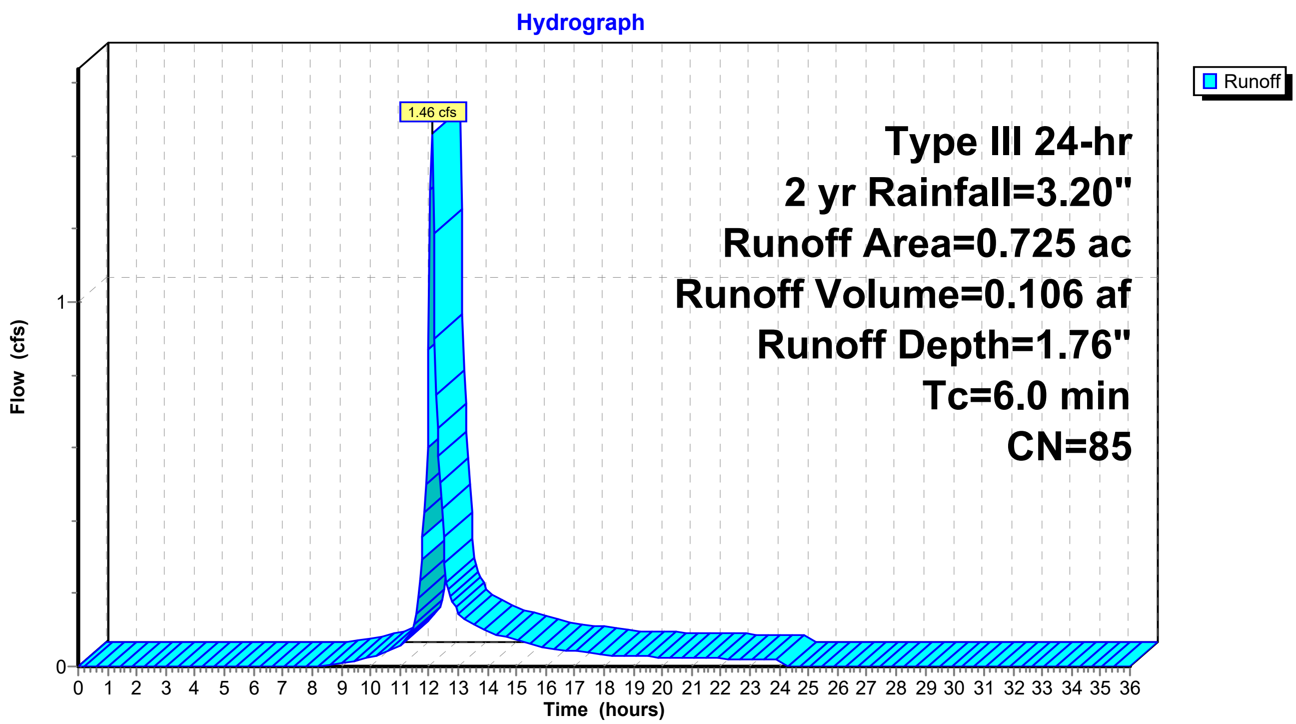
Runoff = 1.46 cfs @ 12.09 hrs, Volume= 0.106 af, Depth= 1.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.20"

Area (ac)	CN	Description
0.249	61	>75% Grass cover, Good, HSG B
0.476	98	Paved parking, HSG B
0.725	85	Weighted Average
0.249		34.34% Pervious Area
0.476		65.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-3A: PR-3A



Summary for Subcatchment PR-3B: PR-3B

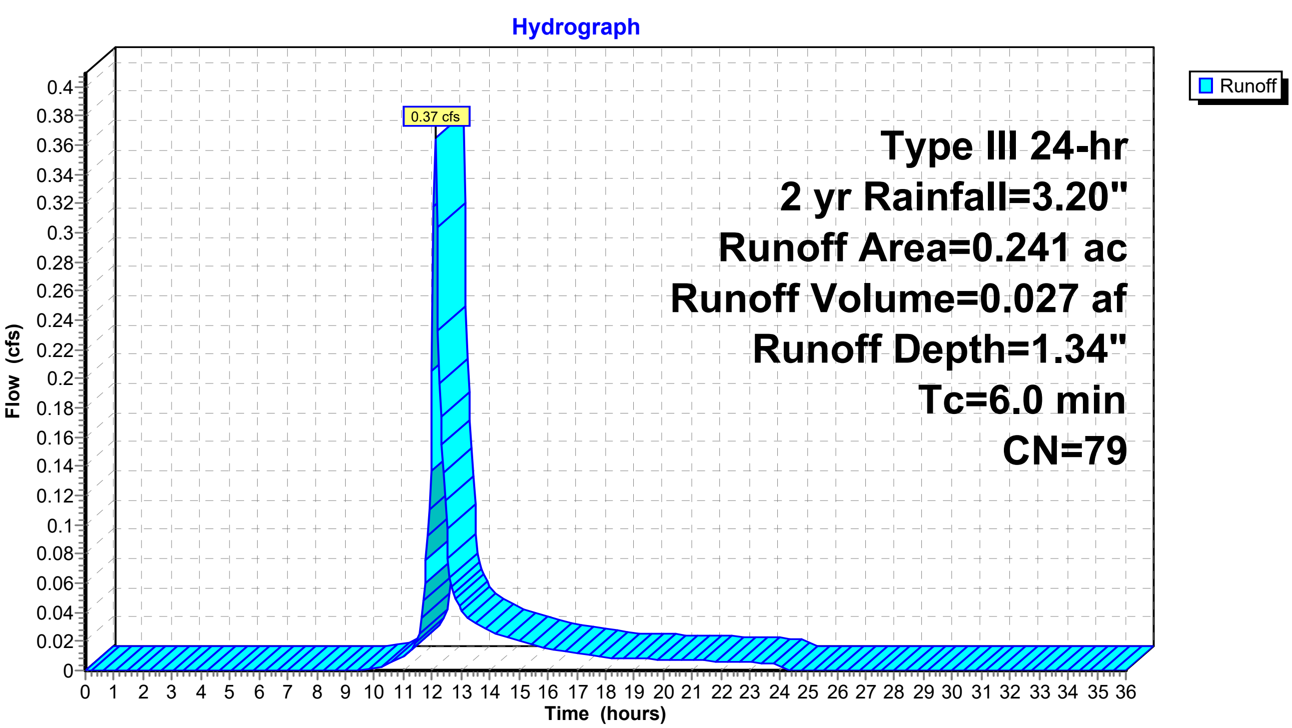
Runoff = 0.37 cfs @ 12.10 hrs, Volume= 0.027 af, Depth= 1.34"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.20"

Area (ac)	CN	Description
0.124	61	>75% Grass cover, Good, HSG B
0.117	98	Paved parking, HSG B
0.241	79	Weighted Average
0.124		51.45% Pervious Area
0.117		48.55% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-3B: PR-3B



Summary for Subcatchment PR-3C: PR-3C

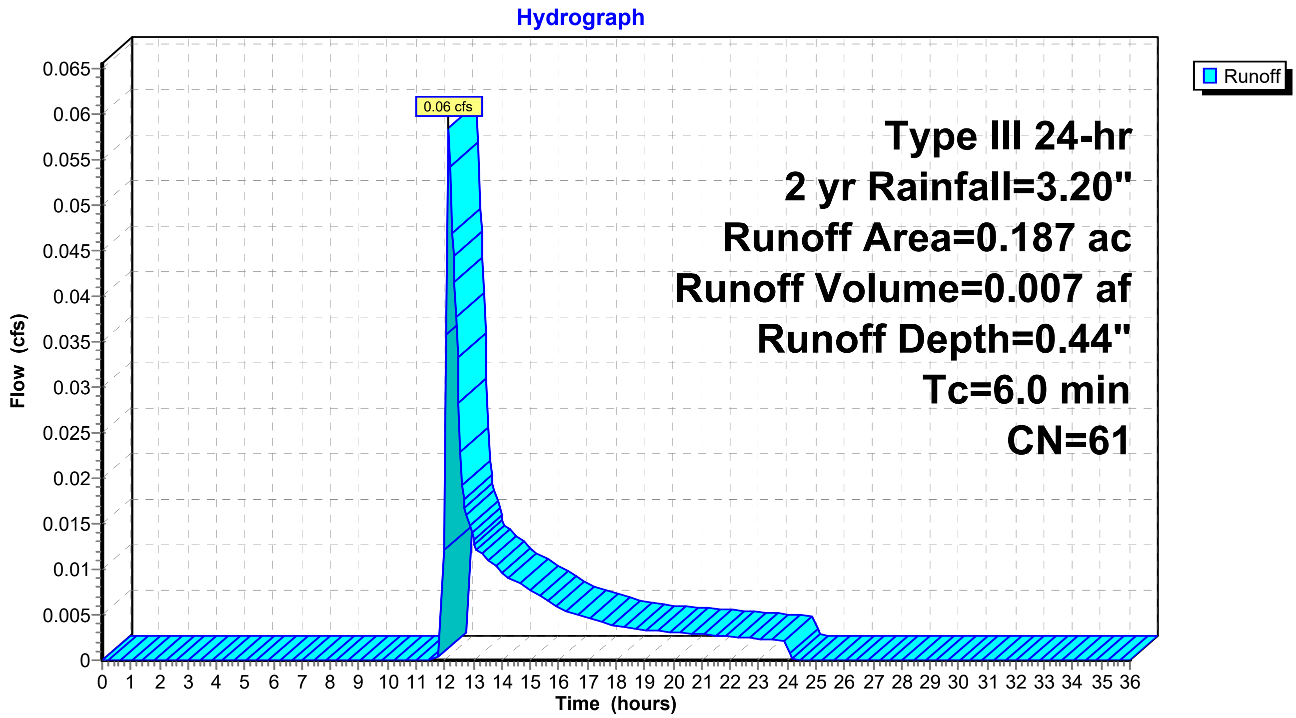
Runoff = 0.06 cfs @ 12.13 hrs, Volume= 0.007 af, Depth= 0.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.20"

Area (ac)	CN	Description
0.187	61	>75% Grass cover, Good, HSG B
0.187		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-3C: PR-3C



Summary for Subcatchment PR-4A: PR-5A

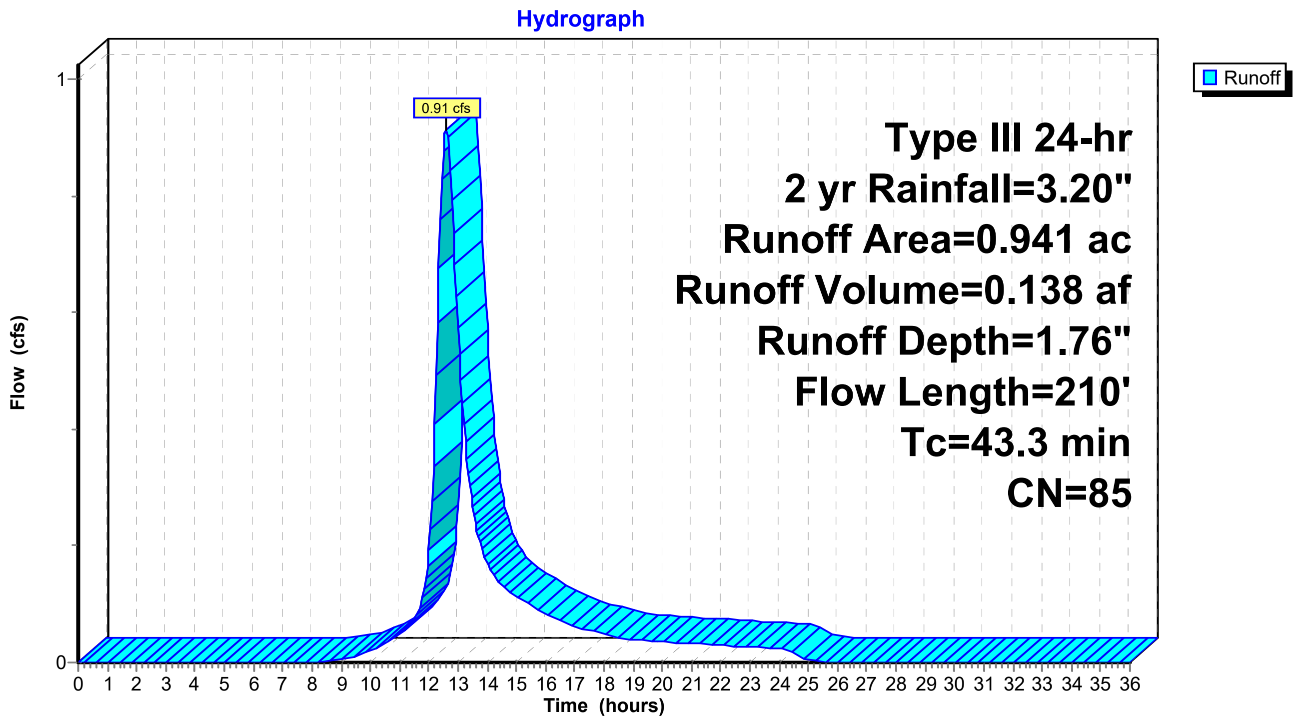
Runoff = 0.91 cfs @ 12.60 hrs, Volume= 0.138 af, Depth= 1.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.20"

	Area (ac)	CN	Description
*	0.941	85	SYNTHETIC TURF- PAD- LINER
	0.941		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
39.6	110	0.0055	0.05		**Sheet Flow, Through Turf Section** Grass: Bermuda n= 0.410 P2= 3.20"
3.7	100	0.0001	0.45	0.16	**Pipe Channel, TRENCH DRAIN LEVEL** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010
43.3	210	Total			

Subcatchment PR-4A: PR-5A



Summary for Subcatchment PR-4B: SB 11 A

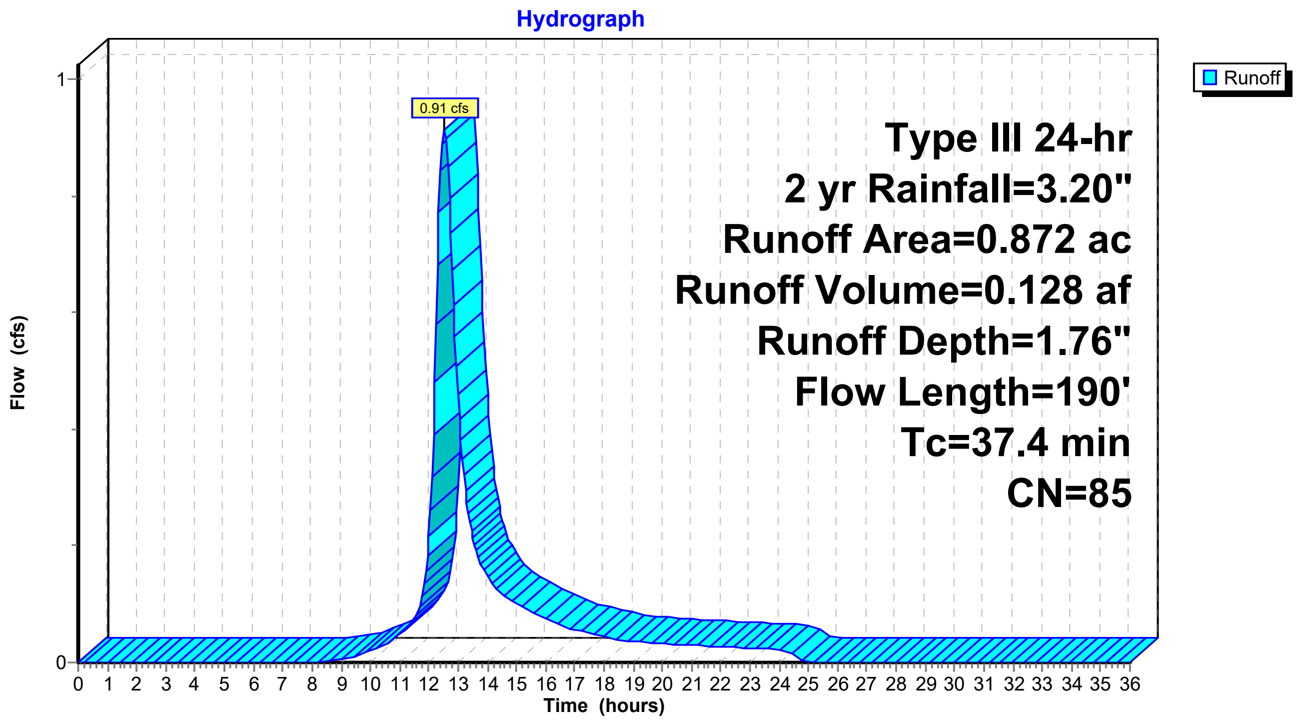
Runoff = 0.91 cfs @ 12.52 hrs, Volume= 0.128 af, Depth= 1.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.20"

	Area (ac)	CN	Description
*	0.872	85	SYNTHETIC TURF- PAD- LINER
	0.872		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
33.7	90	0.0055	0.04		**Sheet Flow, Through Turf Section** Grass: Bermuda n= 0.410 P2= 3.20"
3.7	100	0.0001	0.45	0.16	**Pipe Channel, TRENCH DRAIN LEVEL** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010
37.4	190	Total			

Subcatchment PR-4B: SB 11 A



Summary for Subcatchment PR-4C: SB 00 DPW SLOPE

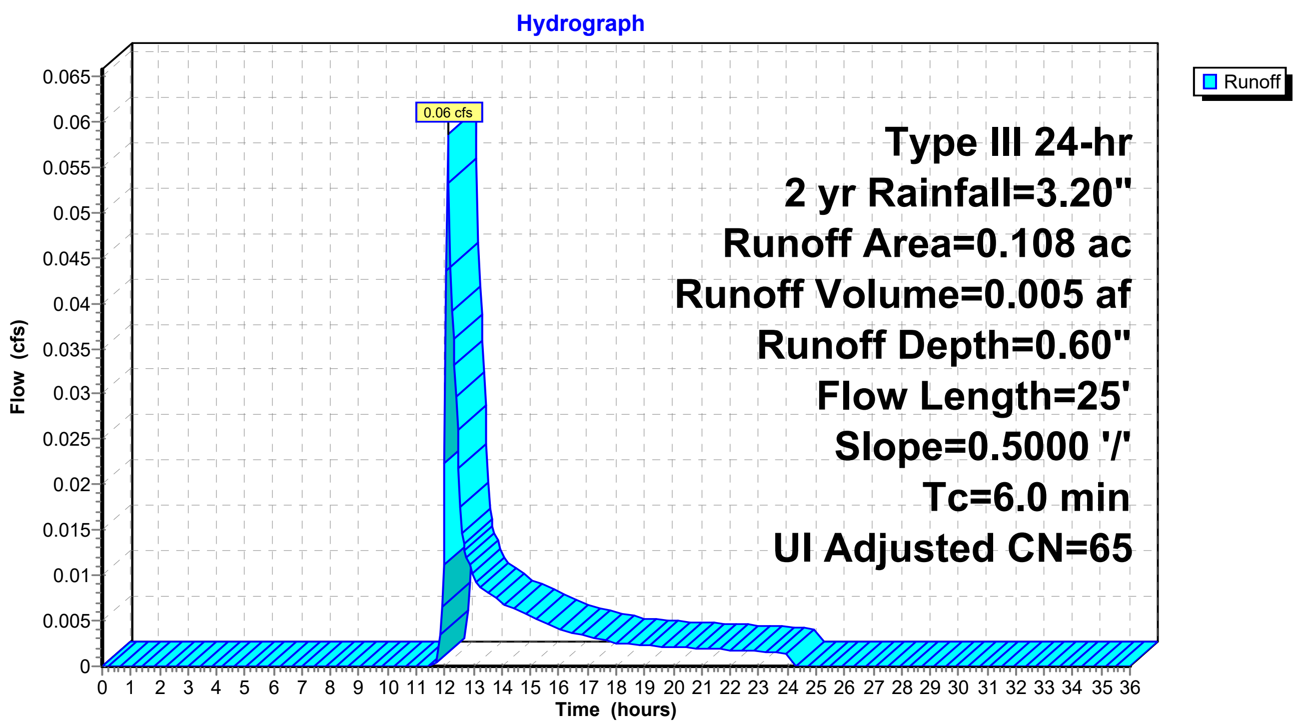
Runoff = 0.06 cfs @ 12.11 hrs, Volume= 0.005 af, Depth= 0.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.20"

Area (ac)	CN	Adj	Description
0.025	98		Unconnected pavement, HSG B
0.083	61		>75% Grass cover, Good, HSG B
0.108	70	65	Weighted Average, UI Adjusted
0.083			76.85% Pervious Area
0.025			23.15% Impervious Area
0.025			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.3	25	0.5000	0.32		**Sheet Flow, SLOPING LAND** Grass: Dense n= 0.240 P2= 3.20"
1.3	25	Total, Increased to minimum Tc = 6.0 min			

Subcatchment PR-4C: SB 00 DPW SLOPE



Summary for Subcatchment PR-5A: BB 01 A

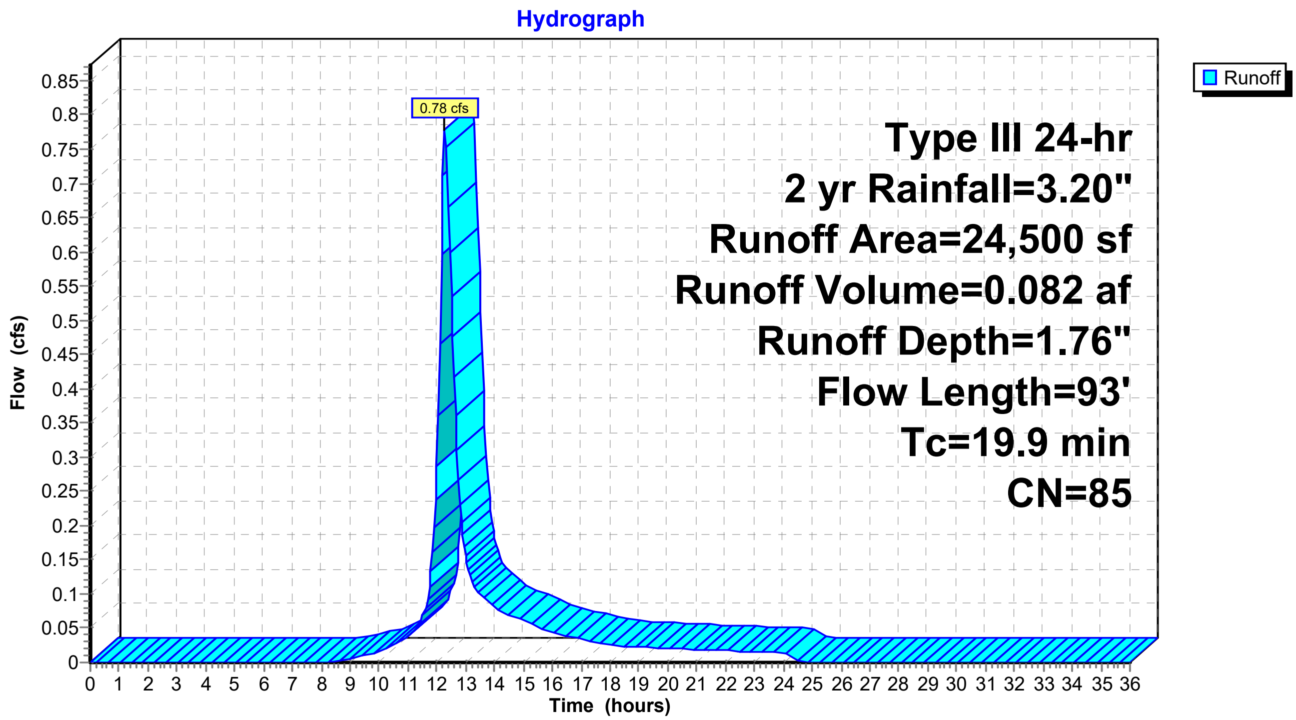
Runoff = 0.78 cfs @ 12.28 hrs, Volume= 0.082 af, Depth= 1.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.20"

	Area (sf)	CN	Description
*	24,500	85	SYNTHETIC TURF- PAD- LINER
	24,500		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.2	46	0.0067	0.04		**Sheet Flow, Through Turf Section** Grass: Bermuda n= 0.410 P2= 3.20"
1.7	47	0.0001	0.45	0.16	**Pipe Channel, TRENCH DRAIN LEVEL** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010
19.9	93	Total			

Subcatchment PR-5A: BB 01 A



Summary for Subcatchment PR-5B: BB 11 A

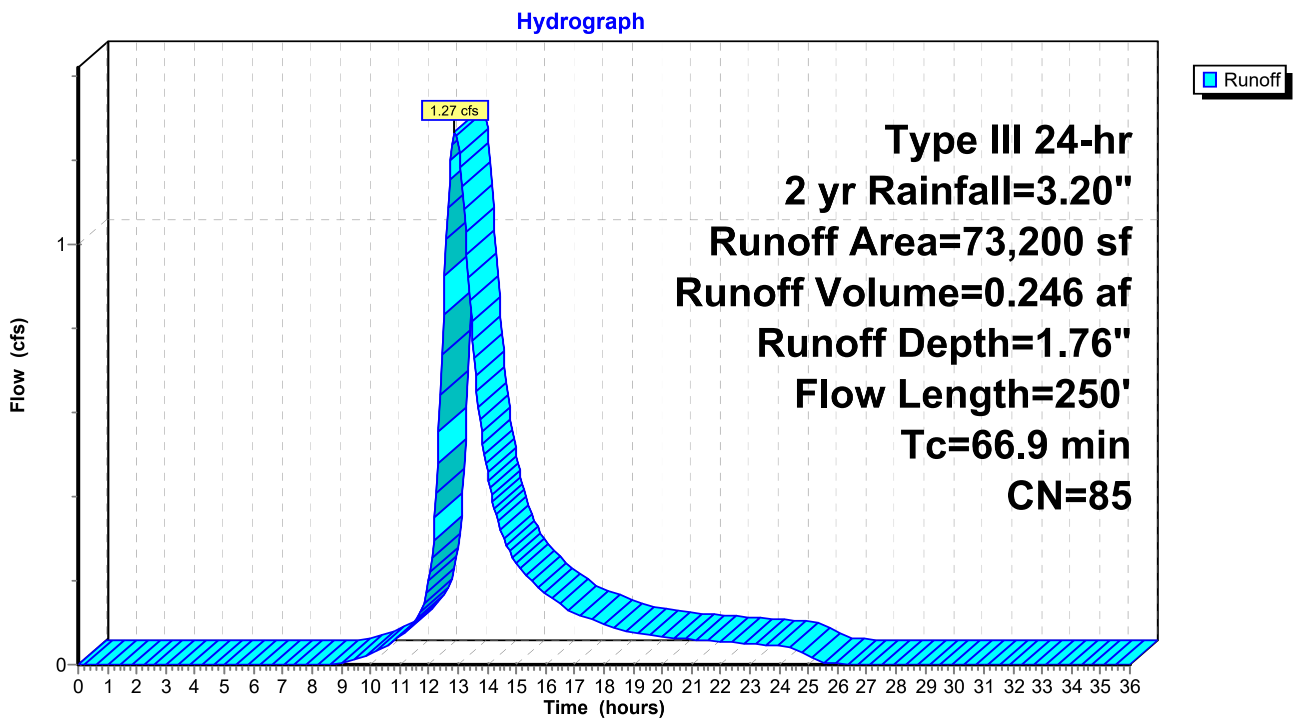
Runoff = 1.27 cfs @ 12.90 hrs, Volume= 0.246 af, Depth= 1.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.20"

	Area (sf)	CN	Description
*	73,200	85	SYNTHETIC TURF- PAD- LINER
	73,200		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.1	53	0.0055	0.04		**Sheet Flow, Through Turf Section** Grass: Bermuda n= 0.410 P2= 3.20"
43.1	150	0.0083	0.06		**Sheet Flow, SYNTHETIC TURF** Grass: Bermuda n= 0.410 P2= 3.20"
1.7	47	0.0001	0.45	0.16	**Pipe Channel, TRENCH DRAIN LEVEL** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010
66.9	250	Total			

Subcatchment PR-5B: BB 11 A



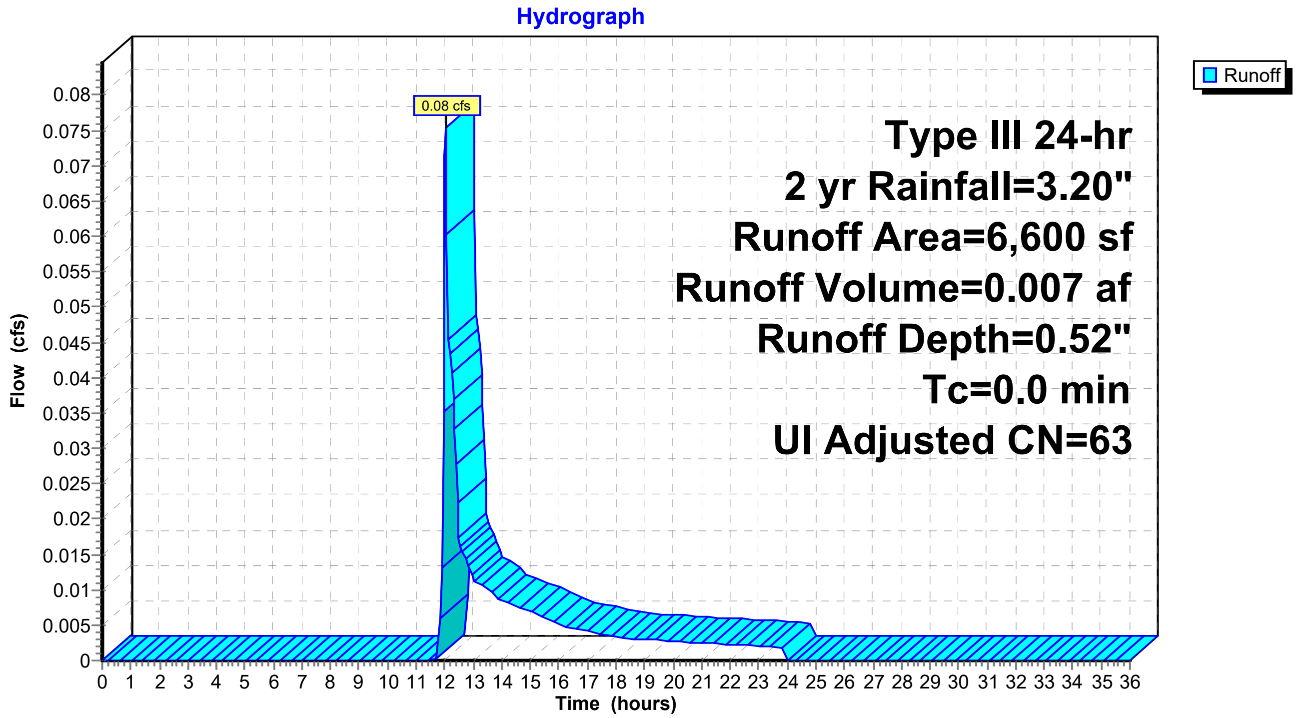
Summary for Subcatchment PR-5C: SLOPE

Runoff = 0.08 cfs @ 12.02 hrs, Volume= 0.007 af, Depth= 0.52"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.20"

Area (sf)	CN	Adj	Description
600	98		Unconnected roofs, HSG B
6,000	61		>75% Grass cover, Good, HSG B
6,600	64	63	Weighted Average, UI Adjusted
6,000			90.91% Pervious Area
600			9.09% Impervious Area
600			100.00% Unconnected

Subcatchment PR-5C: SLOPE



Summary for Pond 1P: rain garden#1 cascading

Inflow Area = 0.725 ac, 65.66% Impervious, Inflow Depth = 1.76" for 2 yr event
Inflow = 1.46 cfs @ 12.09 hrs, Volume= 0.106 af
Outflow = 1.44 cfs @ 12.11 hrs, Volume= 0.104 af, Atten= 1%, Lag= 0.9 min
Primary = 1.44 cfs @ 12.11 hrs, Volume= 0.104 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 61.77' @ 12.11 hrs Surf.Area= 441 sf Storage= 442 cf
Flood Elev= 63.00' Surf.Area= 660 sf Storage= 1,132 cf

Plug-Flow detention time= 76.0 min calculated for 0.104 af (98% of inflow)
Center-of-Mass det. time= 66.2 min (892.3 - 826.1)

Volume	Invert	Avail.Storage	Storage Description
#1	58.50'	1,048 cf	**Rain Garden Envelope (Prismatic)**Listed below (Recalc) 1,348 cf Overall - 300 cf Embedded = 1,048 cf
#2	58.50'	30 cf	**crush stone (Prismatic)**Listed below (Recalc) Inside #1 75 cf Overall x 40.0% Voids
#3	59.00'	50 cf	**Bio Media (Prismatic)**Listed below (Recalc) Inside #1 199 cf Overall x 25.0% Voids
#4	60.33'	5 cf	**Mulch (Prismatic)**Listed below (Recalc) Inside #1 26 cf Overall x 20.0% Voids
		1,132 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
58.50	150	0	0
60.50	150	300	300
61.00	236	97	397
62.00	503	370	766
63.00	660	582	1,348

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
58.50	150	0	0
59.00	150	75	75

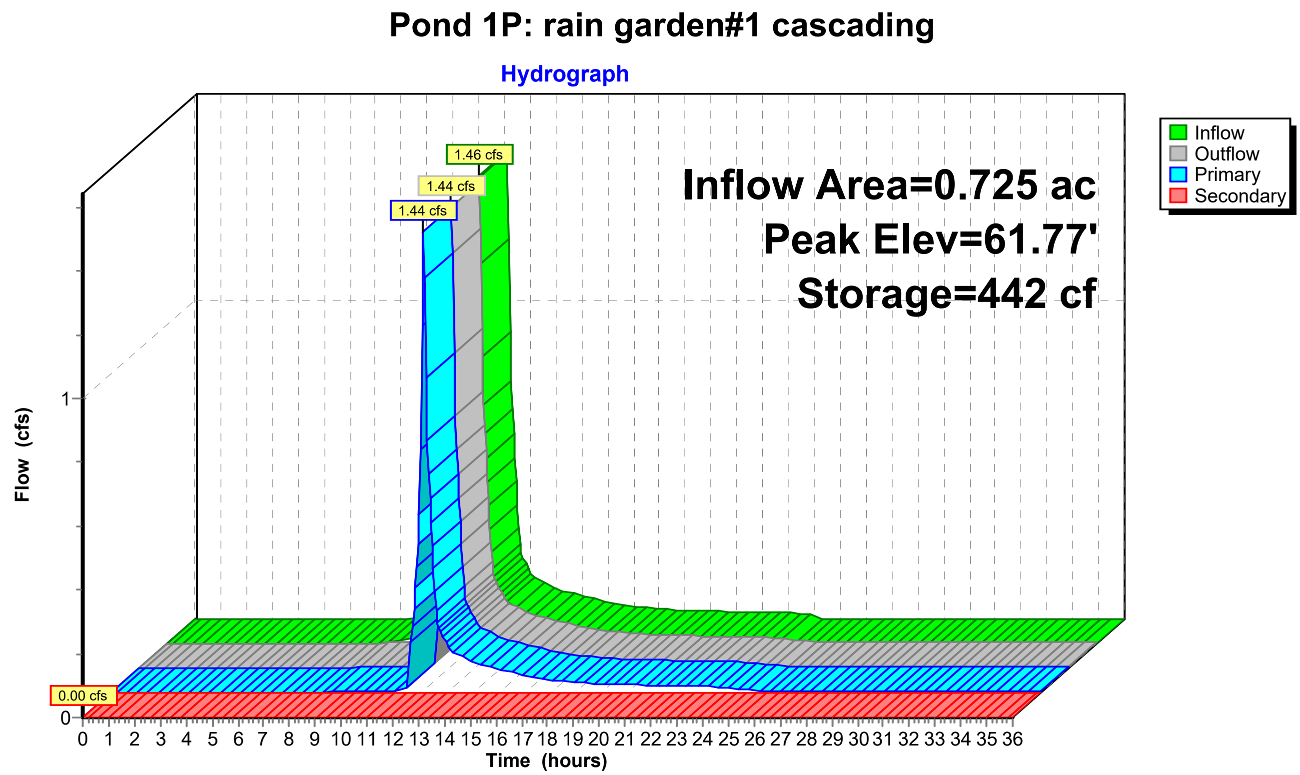
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
59.00	150	0	0
60.33	150	199	199

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
60.33	150	0	0
60.50	150	26	26

Device	Routing	Invert	Outlet Devices
#1	Device 3	58.50'	**1.020 in/hr Exfiltration over Surface area**
#2	Secondary	62.00'	**25.0' long x 3.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32
#3	Primary	58.50'	**8.0" Round Culvert** L= 20.0' Ke= 0.500 Inlet / Outlet Invert= 58.50' / 58.40' S= 0.0050 '/' Cc= 0.900 n= 0.012, Flow Area= 0.35 sf
#4	Device 3	61.50'	**12.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=1.41 cfs @ 12.11 hrs HW=61.77' TW=54.04' (Dynamic Tailwater)
└─**3=Culvert** (Passes 1.41 cfs of 2.88 cfs potential flow)
  ├─**1=Exfiltration** (Exfiltration Controls 0.01 cfs)
  └─**4=Orifice/Grate** (Weir Controls 1.40 cfs @ 1.68 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=58.50' TW=51.00' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)



Summary for Pond 2P: rain garden#2 cascading

Inflow Area = 0.966 ac, 61.39% Impervious, Inflow Depth > 1.63" for 2 yr event
Inflow = 1.81 cfs @ 12.11 hrs, Volume= 0.131 af
Outflow = 1.72 cfs @ 12.13 hrs, Volume= 0.124 af, Atten= 5%, Lag= 1.7 min
Primary = 1.72 cfs @ 12.13 hrs, Volume= 0.124 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 54.05' @ 12.13 hrs Surf.Area= 727 sf Storage= 811 cf
Flood Elev= 55.00' Surf.Area= 1,326 sf Storage= 1,784 cf

Plug-Flow detention time= 120.1 min calculated for 0.124 af (94% of inflow)
Center-of-Mass det. time= 74.7 min (957.5 - 882.8)

Volume	Invert	Avail.Storage	Storage Description
#1	51.00'	1,557 cf	**Rain Garden Envelope (Prismatic)**Listed below (Recalc) 2,357 cf Overall - 800 cf Embedded = 1,557 cf
#2	51.00'	80 cf	**crush stone (Prismatic)**Listed below (Recalc) Inside #1 200 cf Overall x 40.0% Voids
#3	51.50'	133 cf	**Bio Media (Prismatic)**Listed below (Recalc) Inside #1 532 cf Overall x 25.0% Voids
#4	52.83'	14 cf	**Mulch (Prismatic)**Listed below (Recalc) Inside #1 68 cf Overall x 20.0% Voids
		1,784 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
51.00	400	0	0
53.00	400	800	800
54.00	694	547	1,347
55.00	1,326	1,010	2,357

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
51.00	400	0	0
51.50	400	200	200

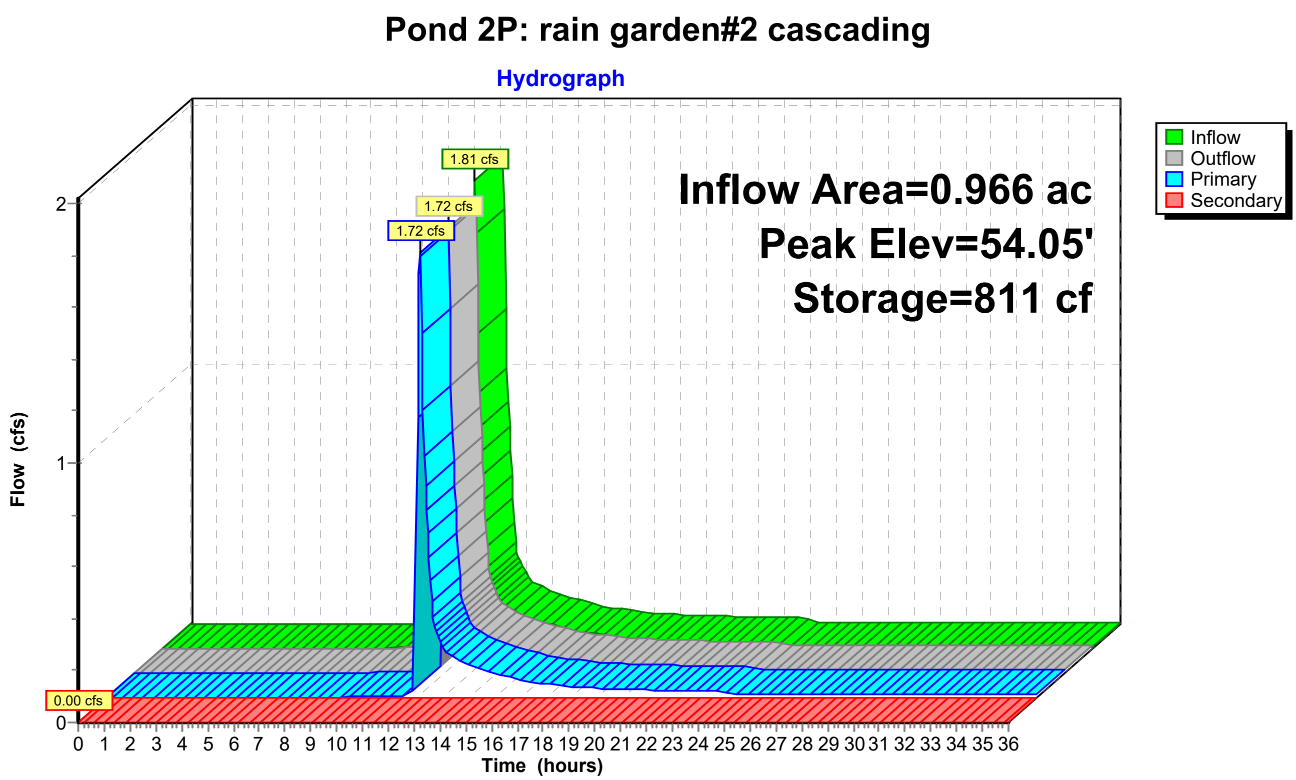
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
51.50	400	0	0
52.83	400	532	532

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
52.83	400	0	0
53.00	400	68	68

Device	Routing	Invert	Outlet Devices
#1	Device 3	51.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Secondary	54.50'	**25.0' long x 3.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32
#3	Primary	51.00'	**12.0" Round Culvert** L= 25.0' Ke= 0.500 Inlet / Outlet Invert= 51.00' / 50.88' S= 0.0048 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf
#4	Device 3	53.75'	**12.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=1.68 cfs @ 12.13 hrs HW=54.05' TW=48.39' (Dynamic Tailwater)
└─**3=Culvert** (Passes 1.68 cfs of 6.04 cfs potential flow)
  ├─**1=Exfiltration** (Exfiltration Controls 0.02 cfs)
  └─**4=Orifice/Grate** (Weir Controls 1.67 cfs @ 1.78 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=51.00' TW=46.00' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)



Summary for Pond 3P: rain garden#3 cascading

Inflow Area = 1.153 ac, 51.43% Impervious, Inflow Depth > 1.36" for 2 yr event
Inflow = 1.78 cfs @ 12.13 hrs, Volume= 0.131 af
Outflow = 1.51 cfs @ 12.26 hrs, Volume= 0.117 af, Atten= 15%, Lag= 7.3 min
Primary = 1.51 cfs @ 12.26 hrs, Volume= 0.117 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 48.86' @ 12.26 hrs Surf.Area= 908 sf Storage= 991 cf
Flood Elev= 50.00' Surf.Area= 1,373 sf Storage= 2,283 cf

Plug-Flow detention time= 183.6 min calculated for 0.116 af (89% of inflow)
Center-of-Mass det. time= 87.4 min (1,042.7 - 955.3)

Volume	Invert	Avail.Storage	Storage Description
#1	46.00'	1,944 cf	**Rain Garden Envelope (Prismatic)** Listed below (Recalc) 3,144 cf Overall - 1,200 cf Embedded = 1,944 cf
#2	46.00'	120 cf	**crush stone (Prismatic)** Listed below (Recalc) Inside #1 300 cf Overall x 40.0% Voids
#3	46.50'	199 cf	**Bio Media (Prismatic)** Listed below (Recalc) Inside #1 798 cf Overall x 25.0% Voids
#4	47.83'	20 cf	**Mulch (Prismatic)** Listed below (Recalc) Inside #1 102 cf Overall x 20.0% Voids
		2,283 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
46.00	600	0	0
48.00	600	1,200	1,200
49.00	957	779	1,979
50.00	1,373	1,165	3,144

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
46.00	600	0	0
46.50	600	300	300

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
46.50	600	0	0
47.83	600	798	798

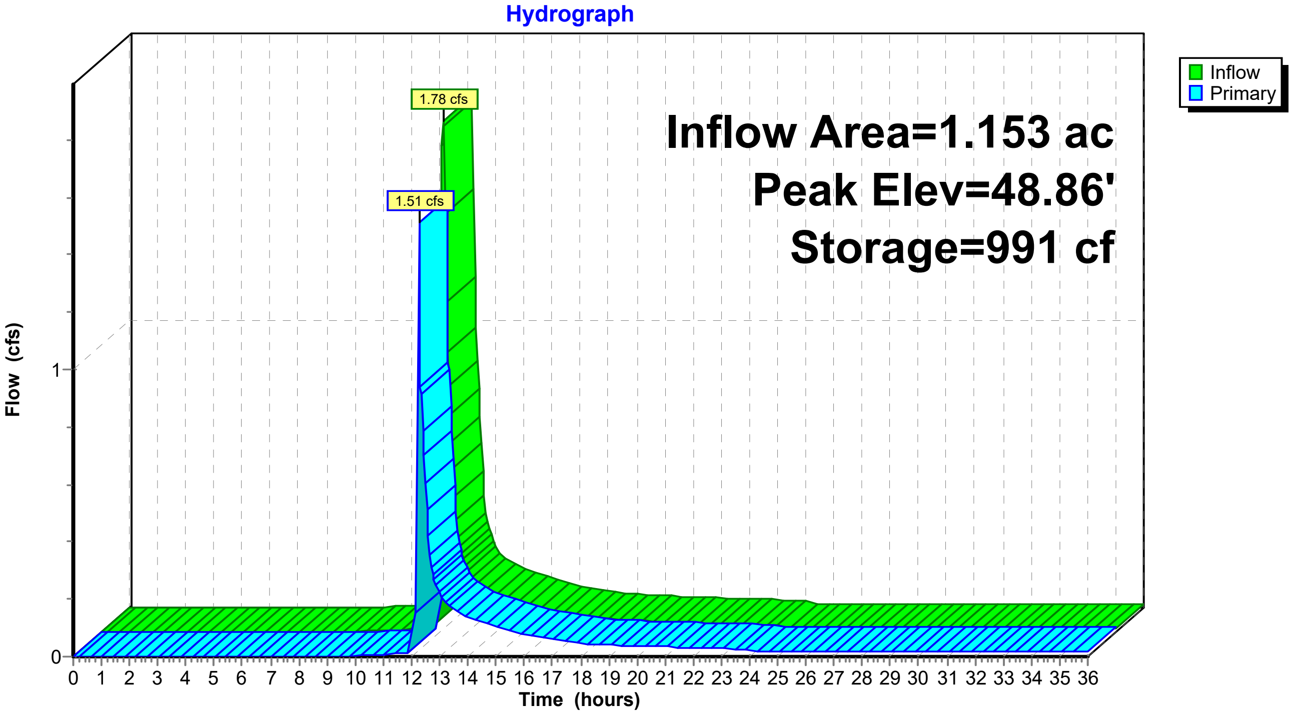
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
47.83	600	0	0
48.00	600	102	102

Device	Routing	Invert	Outlet Devices
#1	Device 3	46.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Device 3	48.75'	**24.0" x 48.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

#3	Primary	46.00'	**15.0" Round Culvert** L= 26.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 46.00' / 45.87' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf

Primary OutFlow Max=1.43 cfs @ 12.26 hrs HW=48.86' TW=0.00' (Dynamic Tailwater)
↑—**3=Culvert** (Passes 1.43 cfs of 6.97 cfs potential flow)
  ↑—**1=Exfiltration** (Exfiltration Controls 0.02 cfs)
  └—**2=Orifice/Grate** (Weir Controls 1.40 cfs @ 1.08 fps)

Pond 3P: rain garden#3 cascading



Summary for Pond 4P: UGS-1

Inflow Area = 1.685 ac, 60.12% Impervious, Inflow Depth = 1.69" for 2 yr event
Inflow = 3.17 cfs @ 12.09 hrs, Volume= 0.238 af
Outflow = 1.96 cfs @ 12.22 hrs, Volume= 0.218 af, Atten= 38%, Lag= 7.6 min
Discarded = 0.04 cfs @ 10.25 hrs, Volume= 0.094 af
Primary = 1.92 cfs @ 12.22 hrs, Volume= 0.124 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 42.31' @ 12.22 hrs Surf.Area= 1,672 sf Storage= 3,125 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 212.8 min (1,030.7 - 817.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	39.50'	2,099 cf	**29.92'W x 55.89'L x 5.50'H Field A** 9,196 cf Overall - 3,198 cf Embedded = 5,998 cf x 35.0% Voids
#2A	40.25'	3,198 cf	**ADS_StormTech MC-3500 d +Cap** x 28 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap 28 Chambers in 4 Rows Cap Storage= +14.9 cf x 2 x 4 rows = 119.2 cf
		5,297 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	39.50'	**24.0" Round Culvert** L= 50.0' Ke= 0.500 Inlet / Outlet Invert= 39.50' / 39.00' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf
#2	Device 1	43.60'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Discarded	39.50'	**1.020 in/hr Exfiltration over Surface area**
#4	Device 1	41.83'	**8.0" Vert. Orifice/Grate X 3.00** C= 0.600

Discarded OutFlow Max=0.04 cfs @ 10.25 hrs HW=39.56' (Free Discharge)
└─**3=Exfiltration** (Exfiltration Controls 0.04 cfs)

Primary OutFlow Max=1.84 cfs @ 12.22 hrs HW=42.30' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Passes 1.84 cfs of 20.16 cfs potential flow)
  ├─**2=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)
  └─**4=Orifice/Grate** (Orifice Controls 1.84 cfs @ 2.33 fps)

Pond 4P: UGS-1 - Chamber Wizard Field A

Chamber Model = ADS_StormTechMC-3500 d +Cap (ADS StormTech®MC-3500 d rev 03/14 with Cap volume)
Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf
Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap
Cap Storage= +14.9 cf x 2 x 4 rows = 119.2 cf

77.0" Wide + 9.0" Spacing = 86.0" C-C Row Spacing

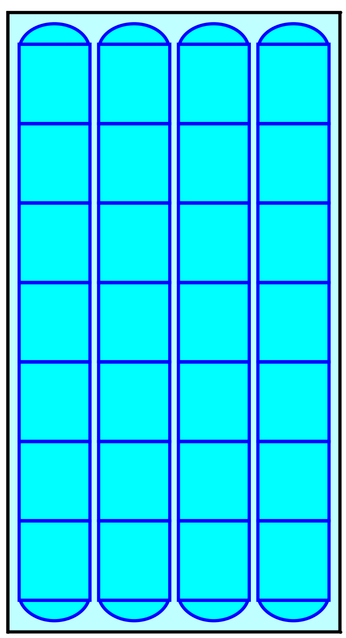
7 Chambers/Row x 7.17' Long +1.85' Cap Length x 2 = 53.89' Row Length +12.0" End Stone x 2 = 55.89' Base Length
4 Rows x 77.0" Wide + 9.0" Spacing x 3 + 12.0" Side Stone x 2 = 29.92' Base Width
9.0" Base + 45.0" Chamber Height + 12.0" Cover = 5.50' Field Height

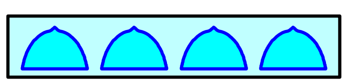
28 Chambers x 110.0 cf + 14.9 cf Cap Volume x 2 x 4 Rows = 3,197.9 cf Chamber Storage

9,196.2 cf Field - 3,197.9 cf Chambers = 5,998.4 cf Stone x 35.0% Voids = 2,099.4 cf Stone Storage

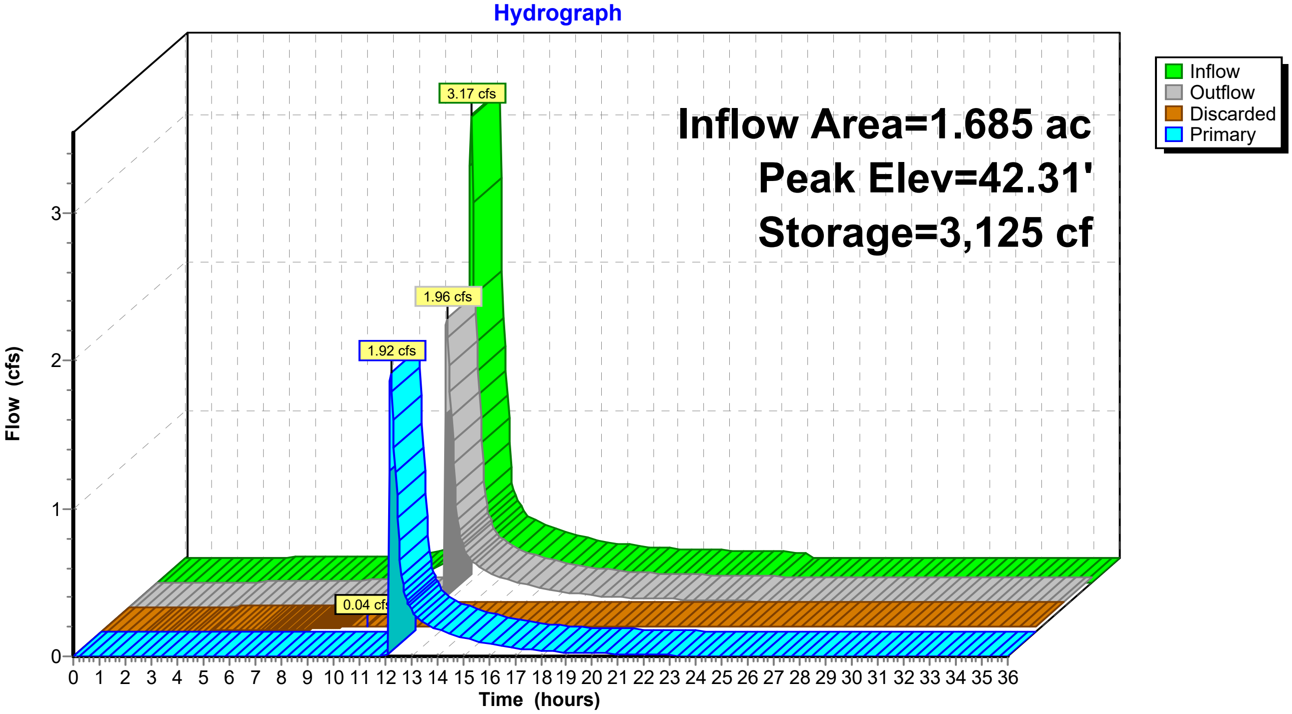
Chamber Storage + Stone Storage = 5,297.3 cf = 0.122 af
Overall Storage Efficiency = 57.6%
Overall System Size = 55.89' x 29.92' x 5.50'

28 Chambers
340.6 cy Field
222.2 cy Stone





Pond 4P: UGS-1


Hydrograph
Inflow
Outflow
Discarded
Primary
Inflow Area=1.685 ac
Peak Elev=42.31'
Storage=3,125 cf
3.17 cfs
1.96 cfs
1.92 cfs
0.04 cfs
Flow (cfs)
0
1
2
3
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36
Time (hours)

Summary for Pond BB 01 B: BB 01 B

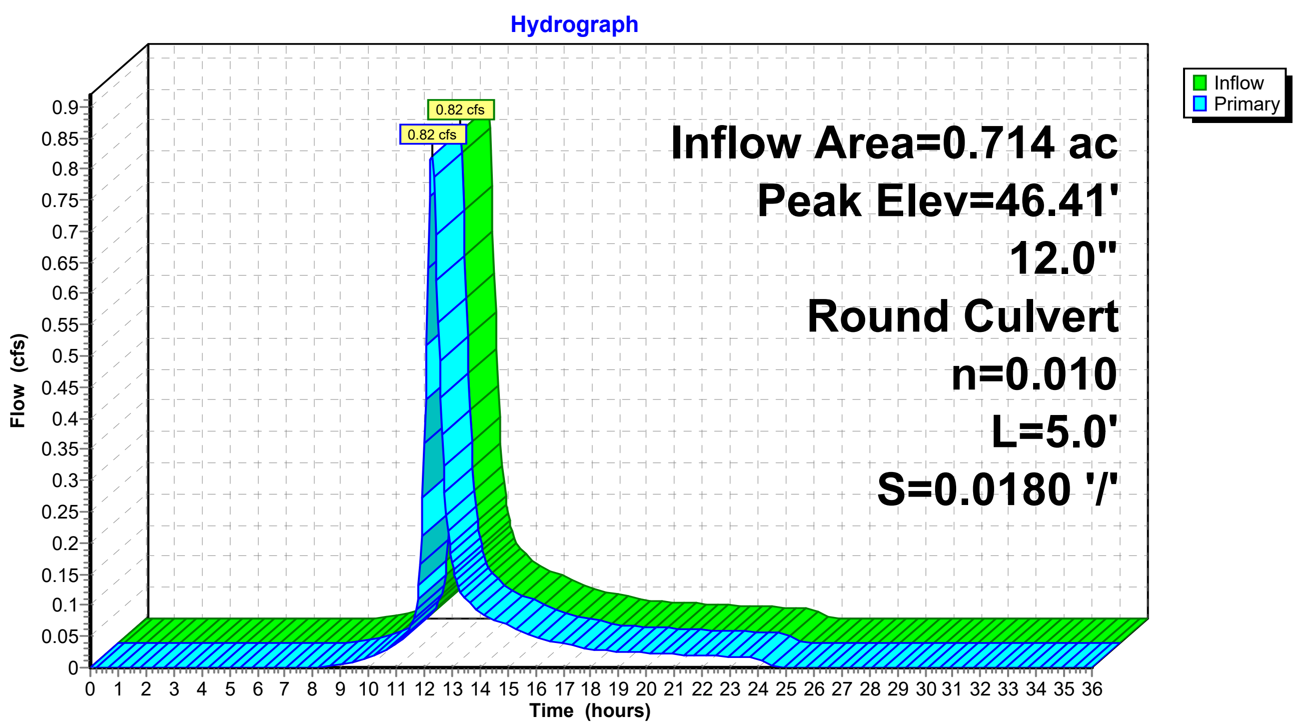
Inflow Area = 0.714 ac, 1.93% Impervious, Inflow Depth = 1.49" for 2 yr event
Inflow = 0.82 cfs @ 12.27 hrs, Volume= 0.089 af
Outflow = 0.82 cfs @ 12.27 hrs, Volume= 0.089 af, Atten= 0%, Lag= 0.0 min
Primary = 0.82 cfs @ 12.27 hrs, Volume= 0.089 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 46.41' @ 12.27 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	45.90'	**12.0" Round Culvert** L= 5.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 45.90' / 45.81' S= 0.0180 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=0.81 cfs @ 12.27 hrs HW=46.41' TW=45.88' (Dynamic Tailwater)
1=Culvert (Barrel Controls 0.81 cfs @ 2.94 fps)

Pond BB 01 B: BB 01 B



Summary for Pond BB 01 S: BB 01 S

Inflow Area = 0.714 ac, 1.93% Impervious, Inflow Depth = 1.49" for 2 yr event
Inflow = 0.82 cfs @ 12.27 hrs, Volume= 0.089 af
Outflow = 0.38 cfs @ 12.64 hrs, Volume= 0.089 af, Atten= 54%, Lag= 22.3 min
Primary = 0.38 cfs @ 12.64 hrs, Volume= 0.089 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 46.08' @ 12.65 hrs Surf.Area= 0 sf Storage= 717 cf

Plug-Flow detention time= 13.5 min calculated for 0.089 af (100% of inflow)
Center-of-Mass det. time= 13.1 min (856.5 - 843.4)

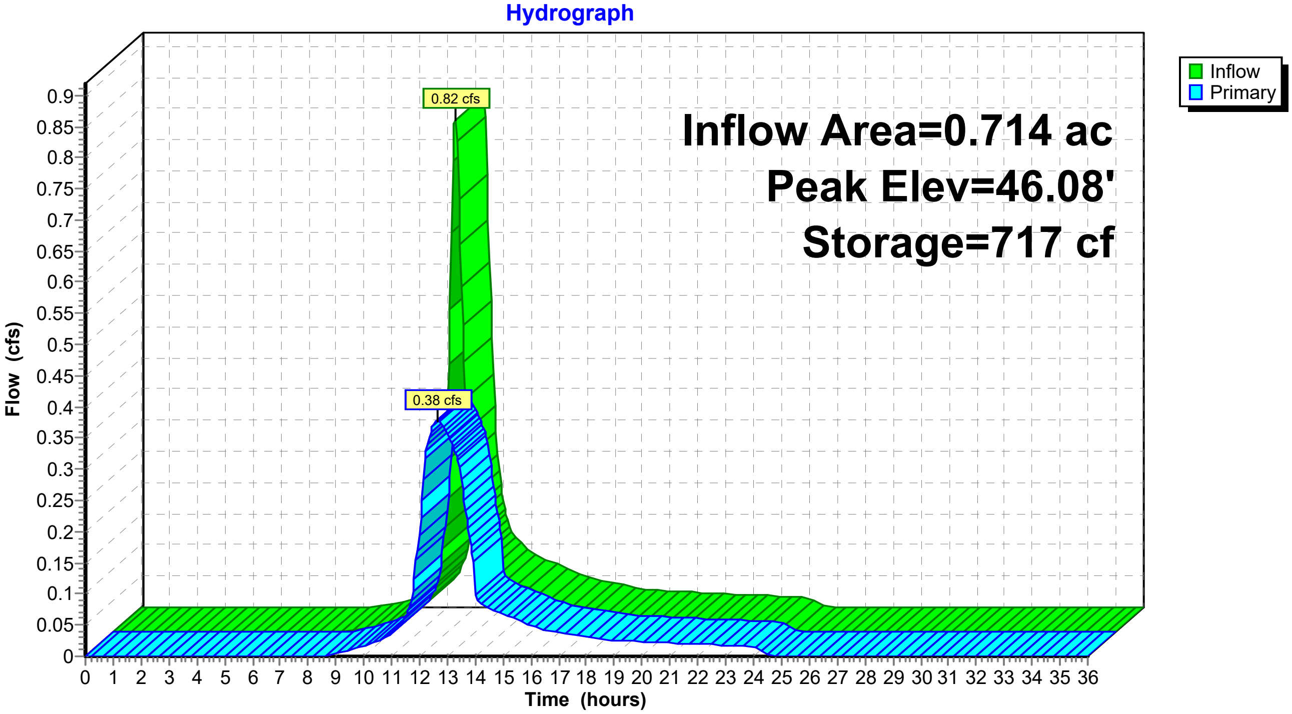
Volume	Invert	Avail.Storage	Storage Description
#1	44.97'	3,256 cf	**Custom Stage Data**Listed below

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
44.97	0	0
45.30	16	16
45.80	236	252
46.30	825	1,077
46.80	876	1,953
47.30	792	2,745
47.80	511	3,256

Device	Routing	Invert	Outlet Devices
#1	Primary	44.97'	**4.0" Round Culvert** L= 8.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 44.97' / 44.87' S= 0.0125 '/' Cc= 0.900 n= 0.010, Flow Area= 0.09 sf
#2	Primary	46.40'	**6.0" Round Culvert** L= 5.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 46.40' / 46.30' S= 0.0200 '/' Cc= 0.900 n= 0.010, Flow Area= 0.20 sf

Primary OutFlow Max=0.38 cfs @ 12.64 hrs HW=46.08' TW=45.27' (Dynamic Tailwater)
1=Culvert (Inlet Controls 0.38 cfs @ 4.33 fps)
2=Culvert (Controls 0.00 cfs)

Pond BB 01 S: BB 01 S



Summary for Pond BB 06 B: BB 06 B

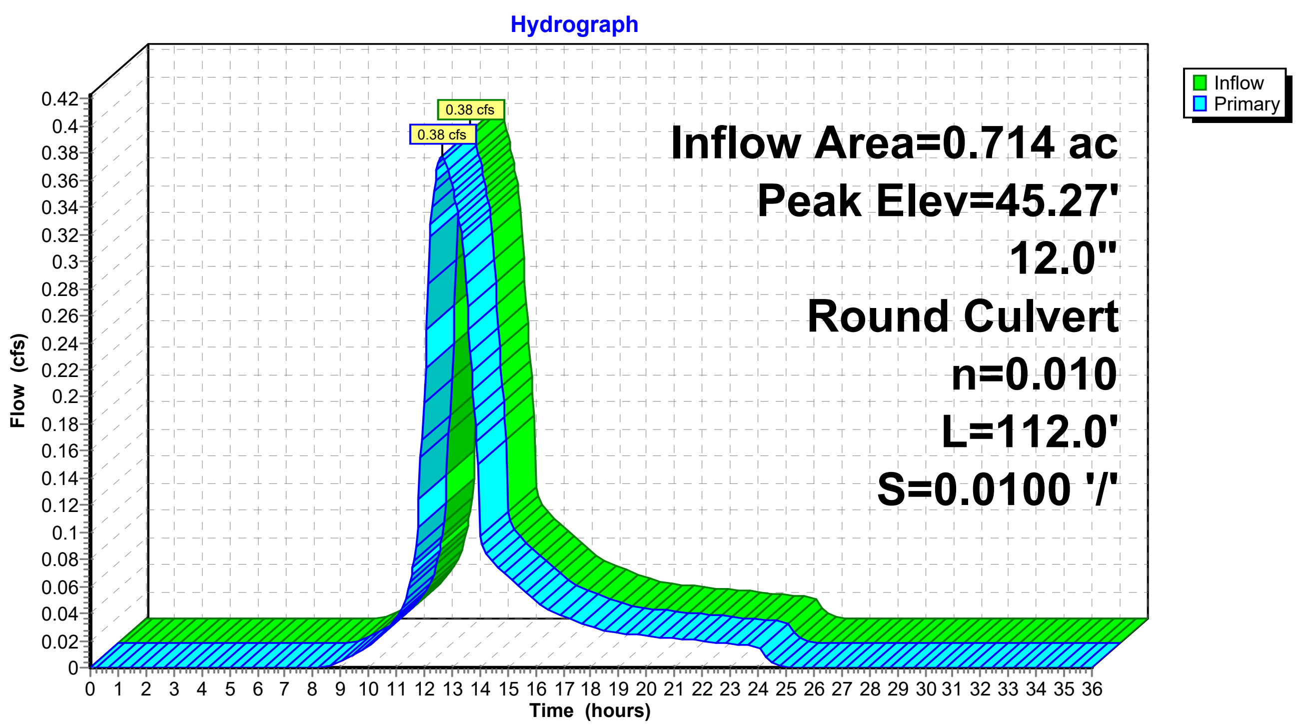
Inflow Area = 0.714 ac, 1.93% Impervious, Inflow Depth = 1.49" for 2 yr event
Inflow = 0.38 cfs @ 12.64 hrs, Volume= 0.089 af
Outflow = 0.38 cfs @ 12.64 hrs, Volume= 0.089 af, Atten= 0%, Lag= 0.0 min
Primary = 0.38 cfs @ 12.64 hrs, Volume= 0.089 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 45.27' @ 12.64 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	44.97'	**12.0" Round Culvert** L= 112.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 44.97' / 43.85' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=0.38 cfs @ 12.64 hrs HW=45.27' TW=43.02' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 0.38 cfs @ 1.88 fps)

Pond BB 06 B: BB 06 B



Summary for Pond BB 11 B: BB 11 B

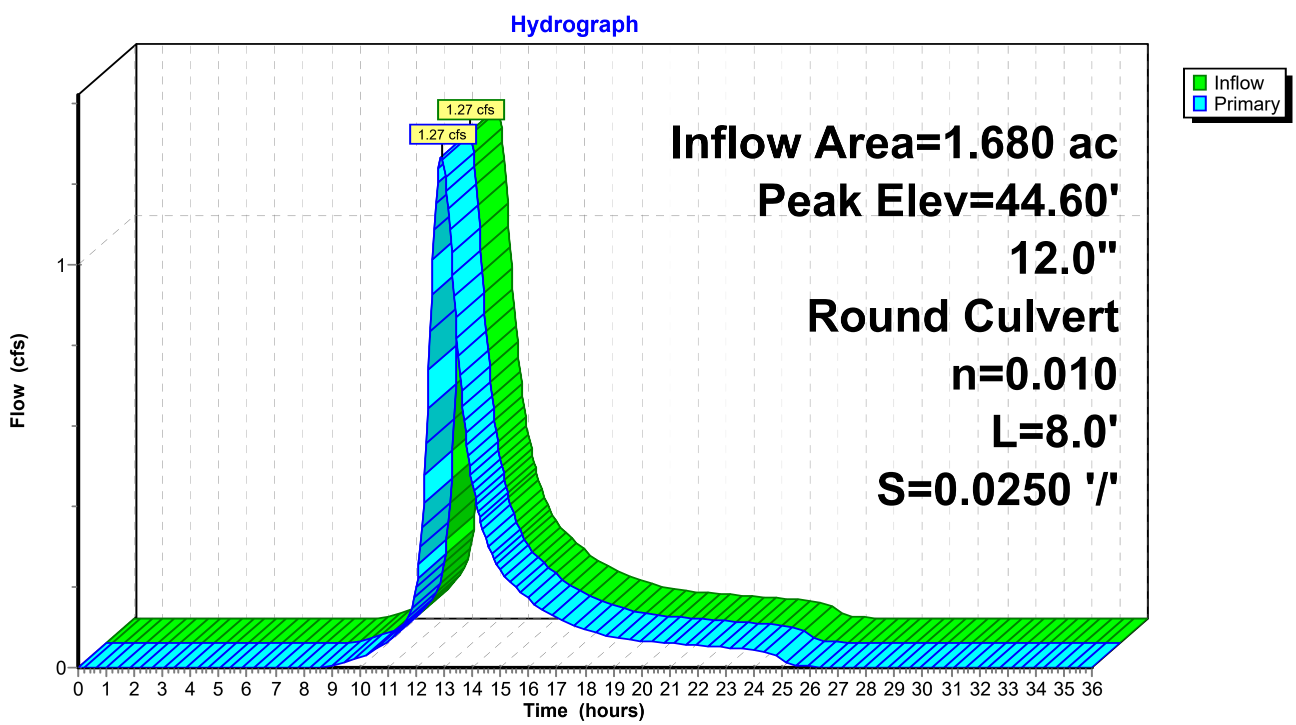
Inflow Area = 1.680 ac, 0.00% Impervious, Inflow Depth = 1.76" for 2 yr event
Inflow = 1.27 cfs @ 12.90 hrs, Volume= 0.246 af
Outflow = 1.27 cfs @ 12.90 hrs, Volume= 0.246 af, Atten= 0%, Lag= 0.0 min
Primary = 1.27 cfs @ 12.90 hrs, Volume= 0.246 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 44.60' @ 12.90 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	44.00'	**12.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 44.00' / 43.80' S= 0.0250 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=1.27 cfs @ 12.90 hrs HW=44.60' TW=43.67' (Dynamic Tailwater)
1=Culvert (Barrel Controls 1.27 cfs @ 3.69 fps)

Pond BB 11 B: BB 11 B



Summary for Pond BB 11 S: BB 11 S

Inflow Area = 1.680 ac, 0.00% Impervious, Inflow Depth = 1.76" for 2 yr event
Inflow = 1.27 cfs @ 12.90 hrs, Volume= 0.246 af
Outflow = 1.13 cfs @ 13.16 hrs, Volume= 0.246 af, Atten= 11%, Lag= 15.6 min
Primary = 1.13 cfs @ 13.16 hrs, Volume= 0.246 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 43.79' @ 13.16 hrs Surf.Area= 0 sf Storage= 489 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 2.3 min (884.8 - 882.5)

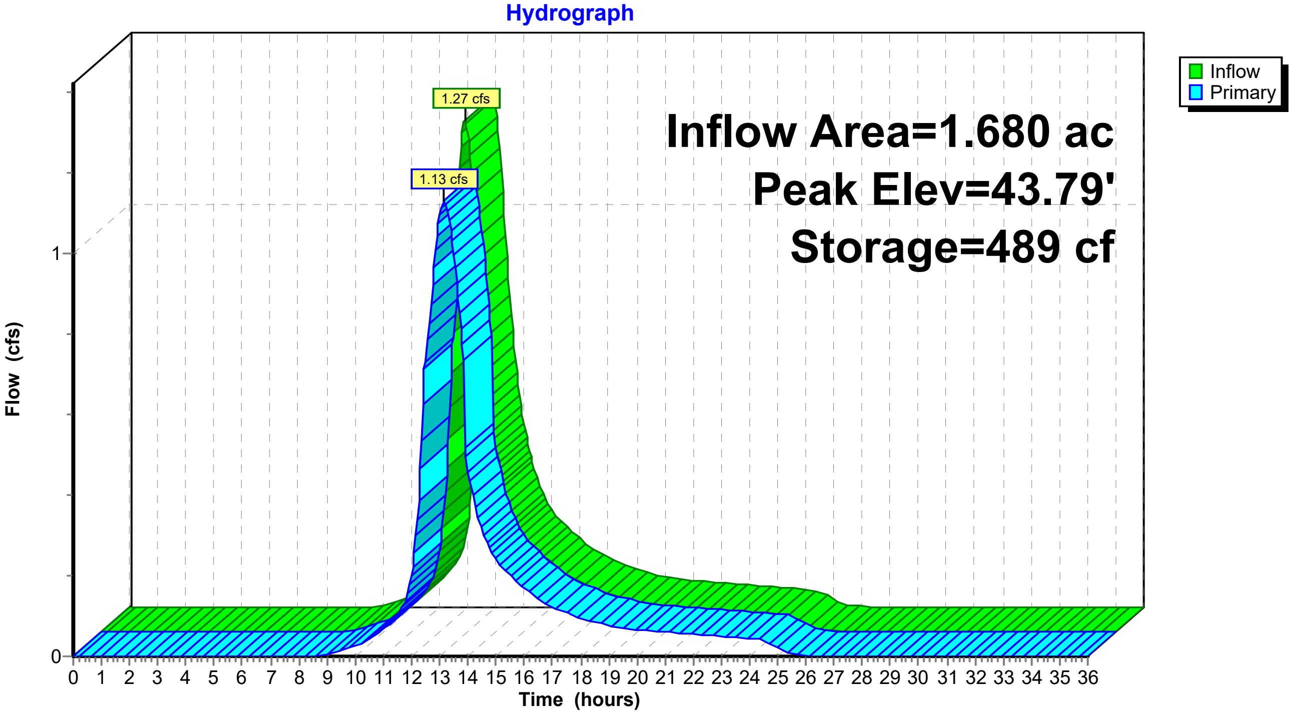
Volume	Invert	Avail.Storage	Storage Description
#1	42.97'	4,778 cf	**Custom Stage Data** Listed below

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
42.97	0	0
43.30	16	16
43.80	481	497
44.30	963	1,460
44.80	1,019	2,479
45.30	1,085	3,564
45.80	603	4,167
46.30	611	4,778

Device	Routing	Invert	Outlet Devices
#1	Primary	42.97'	**4.0" Round Culvert** L= 16.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 42.97' / 42.81' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.09 sf
#2	Primary	39.70'	**6.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 39.70' / 39.60' S= 0.0125 '/' Cc= 0.900 n= 0.010, Flow Area= 0.20 sf
#3	Primary	44.50'	**8.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 44.50' / 44.40' S= 0.0125 '/' Cc= 0.900 n= 0.010, Flow Area= 0.35 sf

Primary OutFlow Max=1.13 cfs @ 13.16 hrs HW=43.79' TW=43.09' (Dynamic Tailwater)
├─**1=Culvert** (Barrel Controls 0.34 cfs @ 3.87 fps)
├─**2=Culvert** (Inlet Controls 0.79 cfs @ 4.04 fps)
└─**3=Culvert** (Controls 0.00 cfs)

Pond BB 11 S: BB 11 S



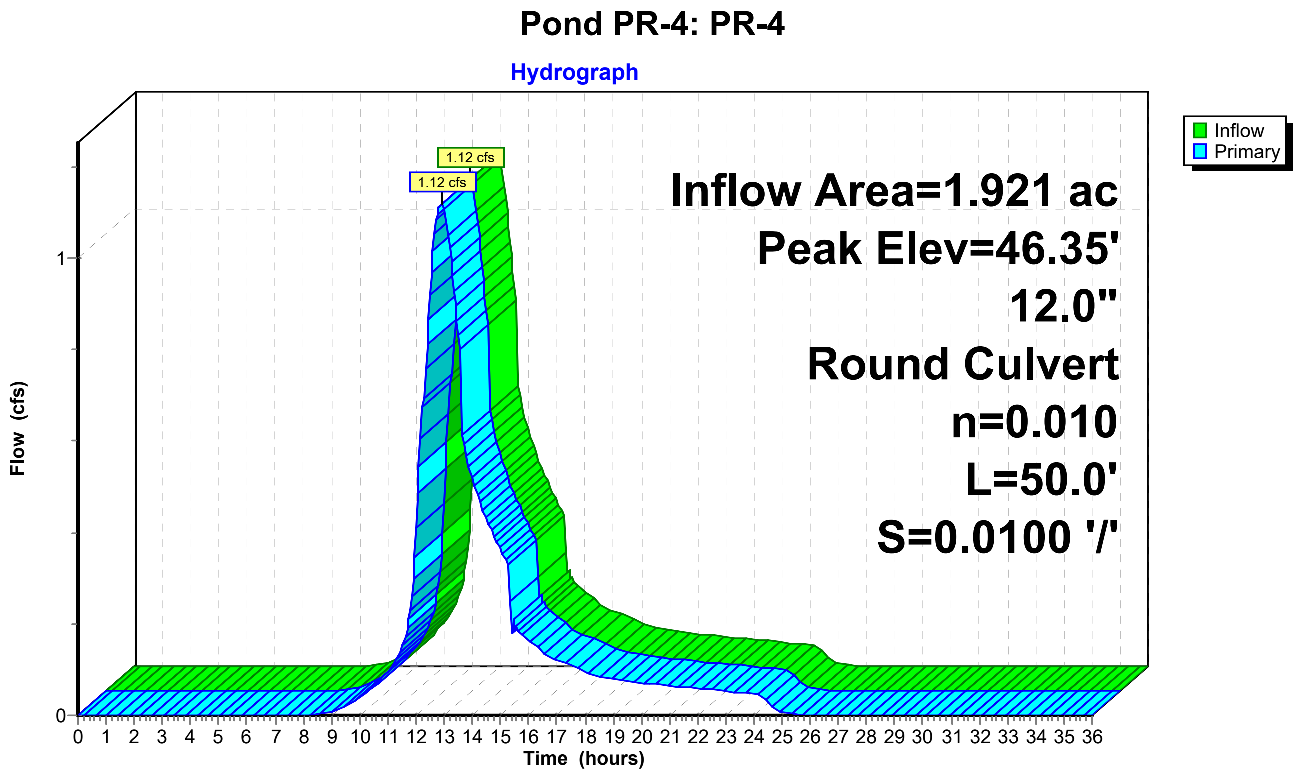
Summary for Pond PR-4: PR-4

Inflow Area =	1.921 ac,	1.30% Impervious, Inflow Depth = 1.69"	for 2 yr event	
Inflow =	1.12 cfs @	12.91 hrs, Volume=	0.271 af	
Outflow =	1.12 cfs @	12.91 hrs, Volume=	0.271 af,	Atten= 0%, Lag= 0.0 min
Primary =	1.12 cfs @	12.91 hrs, Volume=	0.271 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 46.35' @ 12.91 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	45.80'	**12.0" Round Culvert** L= 50.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 45.80' / 45.30' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=1.12 cfs @ 12.91 hrs HW=46.35' TW=0.00' (Dynamic Tailwater)
1=Culvert (Inlet Controls 1.12 cfs @ 2.53 fps)



Summary for Pond PR-5: PR-5

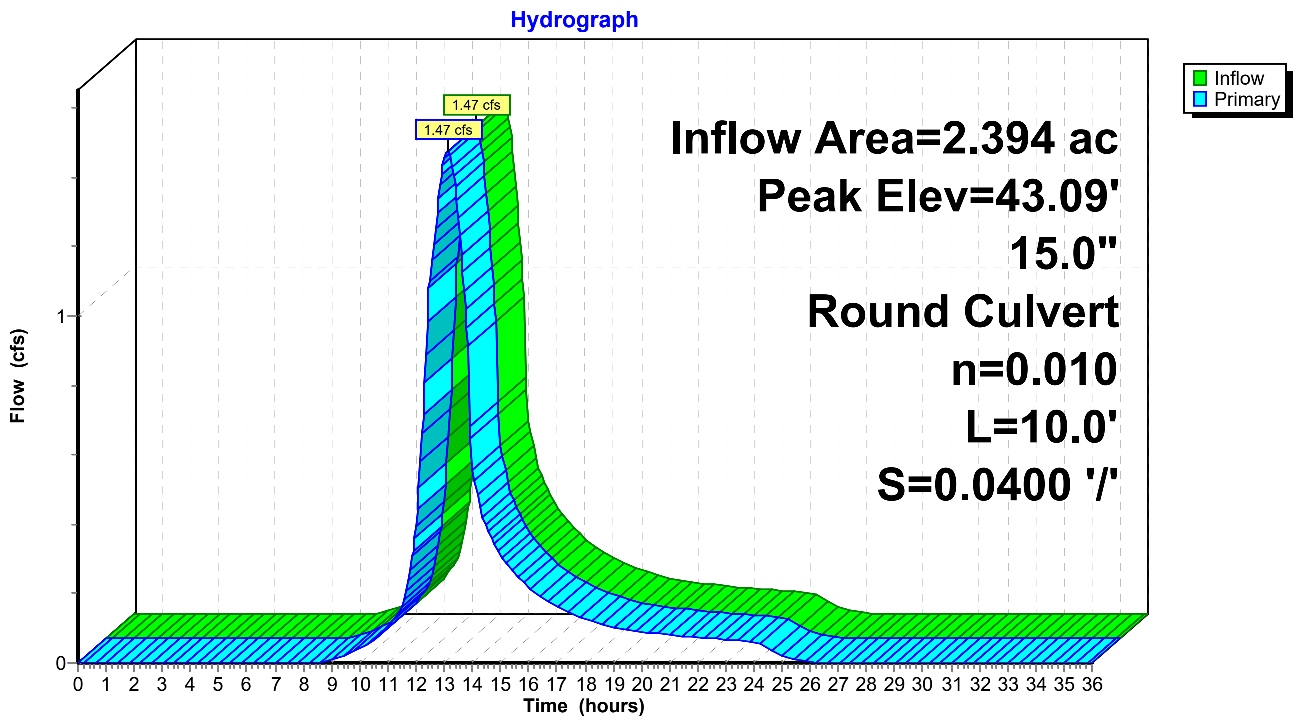
Inflow Area =	2.394 ac,	0.58% Impervious, Inflow Depth = 1.68"	for 2 yr event	
Inflow =	1.47 cfs @	13.12 hrs, Volume=	0.335 af	
Outflow =	1.47 cfs @	13.12 hrs, Volume=	0.335 af,	Atten= 0%, Lag= 0.0 min
Primary =	1.47 cfs @	13.12 hrs, Volume=	0.335 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 43.09' @ 13.12 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	42.50'	**15.0" Round Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 42.50' / 42.10' S= 0.0400 '/' Cc= 0.900 n= 0.010, Flow Area= 1.23 sf

Primary OutFlow Max=1.47 cfs @ 13.12 hrs HW=43.09' TW=0.00' (Dynamic Tailwater)
1=Culvert (Inlet Controls 1.47 cfs @ 2.61 fps)

Pond PR-5: PR-5



Summary for Pond SB 01 B: SB 01 B

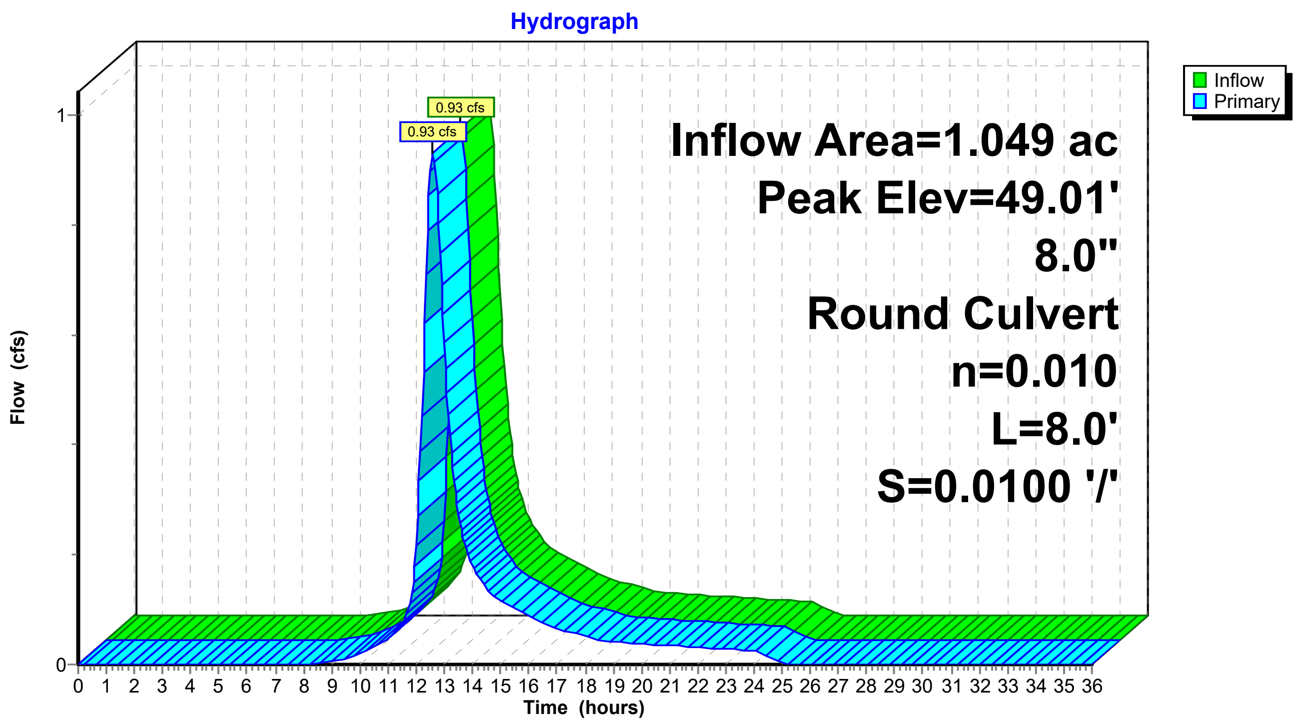
Inflow Area = 1.049 ac, 2.38% Impervious, Inflow Depth = 1.64" for 2 yr event
Inflow = 0.93 cfs @ 12.59 hrs, Volume= 0.143 af
Outflow = 0.93 cfs @ 12.59 hrs, Volume= 0.143 af, Atten= 0%, Lag= 0.0 min
Primary = 0.93 cfs @ 12.59 hrs, Volume= 0.143 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 49.01' @ 12.59 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	48.30'	**8.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 48.30' / 48.22' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.35 sf

Primary OutFlow Max=0.93 cfs @ 12.59 hrs HW=49.01' TW=47.19' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 0.93 cfs @ 3.12 fps)

Pond SB 01 B: SB 01 B



Summary for Pond SB 01 S: SB 01 S

Inflow Area = 1.049 ac, 2.38% Impervious, Inflow Depth = 1.64" for 2 yr event
Inflow = 0.93 cfs @ 12.59 hrs, Volume= 0.143 af
Outflow = 0.74 cfs @ 12.85 hrs, Volume= 0.143 af, Atten= 21%, Lag= 15.5 min
Primary = 0.74 cfs @ 12.85 hrs, Volume= 0.143 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 47.33' @ 12.86 hrs Surf.Area= 0 sf Storage= 455 cf

Plug-Flow detention time= 4.0 min calculated for 0.143 af (100% of inflow)
Center-of-Mass det. time= 4.1 min (866.0 - 862.0)

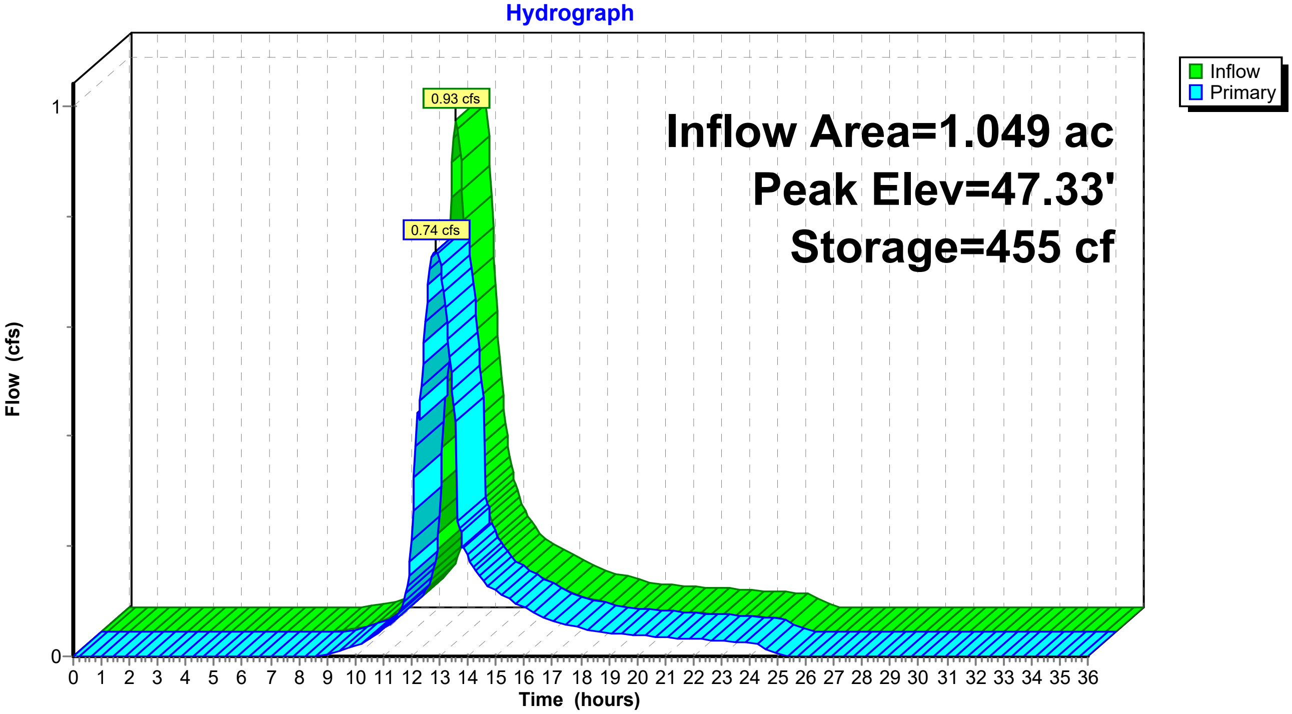
Volume	Invert	Avail.Storage	Storage Description
#1	46.30'	4,121 cf	**Custom Stage Data**Listed below

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
46.30	0	0
46.80	16	16
47.30	386	402
47.80	837	1,239
48.30	886	2,125
48.80	943	3,068
49.30	523	3,591
49.80	530	4,121

Device	Routing	Invert	Outlet Devices
#1	Primary	46.30'	**6.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 46.30' / 46.20' S= 0.0125 '/' Cc= 0.900 n= 0.010, Flow Area= 0.20 sf
#2	Primary	48.30'	**8.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 48.30' / 48.22' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.35 sf

Primary OutFlow Max=0.74 cfs @ 12.85 hrs HW=47.33' TW=46.73' (Dynamic Tailwater)
1=Culvert (Inlet Controls 0.74 cfs @ 3.74 fps)
2=Culvert (Controls 0.00 cfs)

Pond SB 01 S: SB 01 S



Summary for Pond SB 03 B: SB 03B

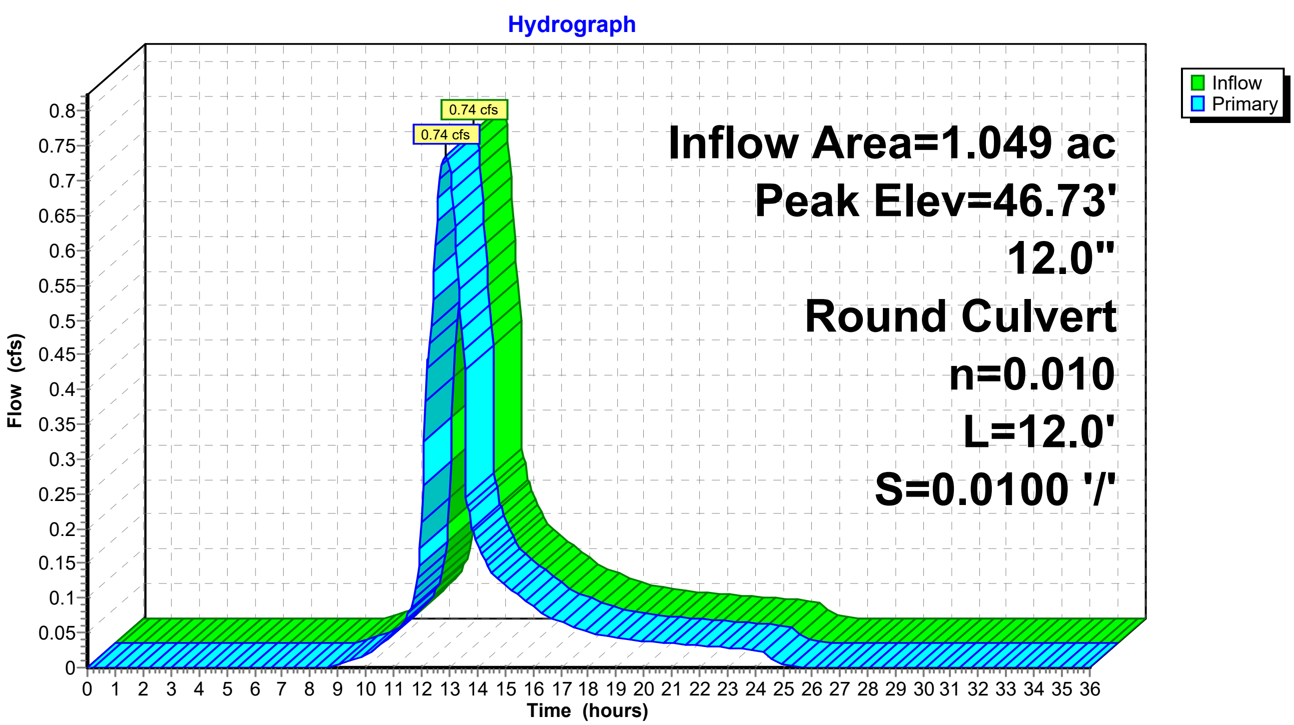
Inflow Area =	1.049 ac,	2.38% Impervious,	Inflow Depth = 1.64"	for 2 yr event	
Inflow =	0.74 cfs @	12.85 hrs,	Volume=	0.143 af	
Outflow =	0.74 cfs @	12.85 hrs,	Volume=	0.143 af,	Atten= 0%, Lag= 0.0 min
Primary =	0.74 cfs @	12.85 hrs,	Volume=	0.143 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 46.73' @ 12.85 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	46.25'	**12.0" Round Culvert** L= 12.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 46.25' / 46.13' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=0.74 cfs @ 12.85 hrs HW=46.73' TW=46.35' (Dynamic Tailwater)
1=Culvert (Barrel Controls 0.74 cfs @ 2.92 fps)

Pond SB 03 B: SB 03B



Summary for Pond SB 11 B: SB 11 B

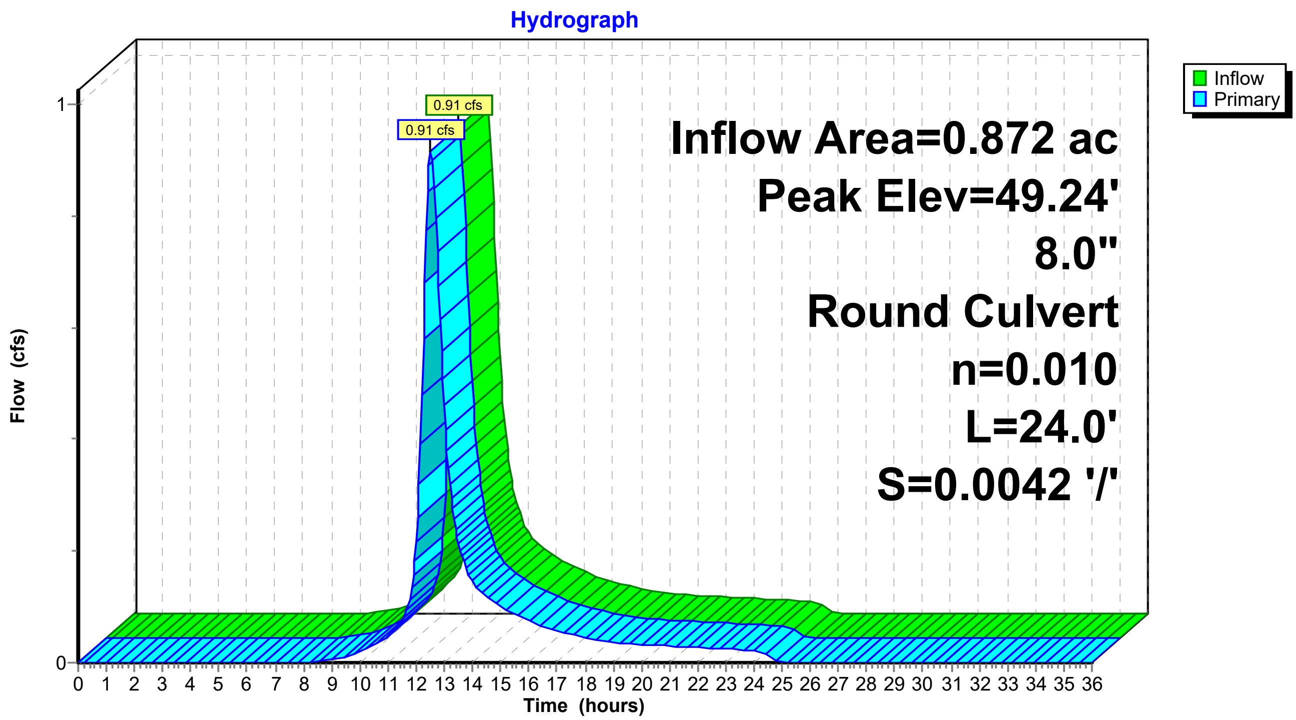
Inflow Area =	0.872 ac,	0.00% Impervious, Inflow Depth = 1.76"	for 2 yr event
Inflow =	0.91 cfs @	12.52 hrs, Volume=	0.128 af
Outflow =	0.91 cfs @	12.52 hrs, Volume=	0.128 af, Atten= 0%, Lag= 0.0 min
Primary =	0.91 cfs @	12.52 hrs, Volume=	0.128 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 49.24' @ 12.52 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	48.50'	**8.0" Round Culvert** L= 24.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 48.50' / 48.40' S= 0.0042 '/' Cc= 0.900 n= 0.010, Flow Area= 0.35 sf

Primary OutFlow Max=0.91 cfs @ 12.52 hrs HW=49.23' TW=47.66' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 0.91 cfs @ 2.96 fps)

Pond SB 11 B: SB 11 B



Summary for Pond SB 11 S: SB 11 S

Inflow Area = 0.872 ac, 0.00% Impervious, Inflow Depth = 1.76" for 2 yr event
Inflow = 0.91 cfs @ 12.52 hrs, Volume= 0.128 af
Outflow = 0.39 cfs @ 13.09 hrs, Volume= 0.128 af, Atten= 57%, Lag= 34.0 min
Primary = 0.39 cfs @ 13.09 hrs, Volume= 0.128 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 47.99' @ 13.09 hrs Surf.Area= 0 sf Storage= 1,263 cf

Plug-Flow detention time= 24.8 min calculated for 0.128 af (100% of inflow)
Center-of-Mass det. time= 24.4 min (879.6 - 855.2)

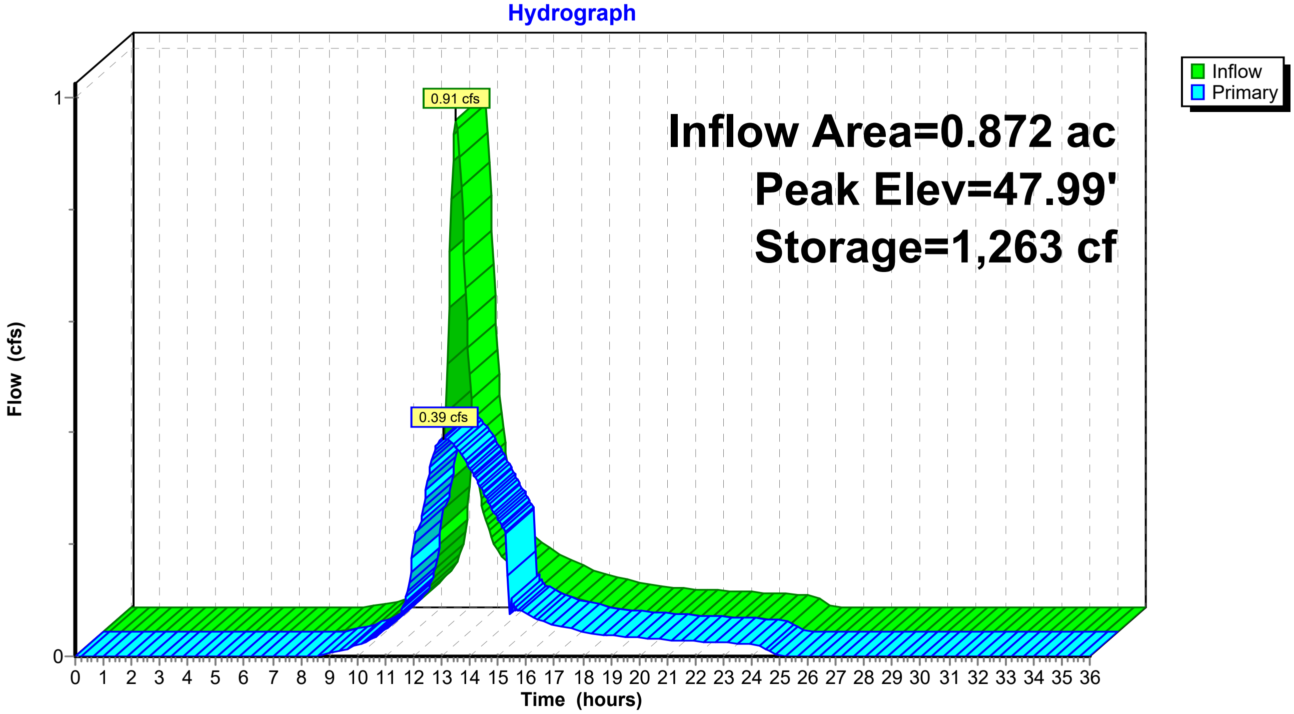
Volume	Invert	Avail.Storage	Storage Description
#1	46.80'	3,953 cf	**Custom Stage Data** Listed below

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
46.80	0	0
47.30	16	16
47.80	888	904
48.30	944	1,848
48.80	1,001	2,849
49.30	544	3,393
49.80	560	3,953

Device	Routing	Invert	Outlet Devices
#1	Primary	46.80'	**4.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 46.80' / 46.72' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.09 sf
#2	Primary	48.10'	**8.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 48.10' / 48.00' S= 0.0125 '/' Cc= 0.900 n= 0.010, Flow Area= 0.35 sf

Primary OutFlow Max=0.39 cfs @ 13.09 hrs HW=47.99' TW=47.13' (Dynamic Tailwater)
├─**1=Culvert** (Inlet Controls 0.39 cfs @ 4.47 fps)
└─**2=Culvert** (Controls 0.00 cfs)

Pond SB 11 S: SB 11 S



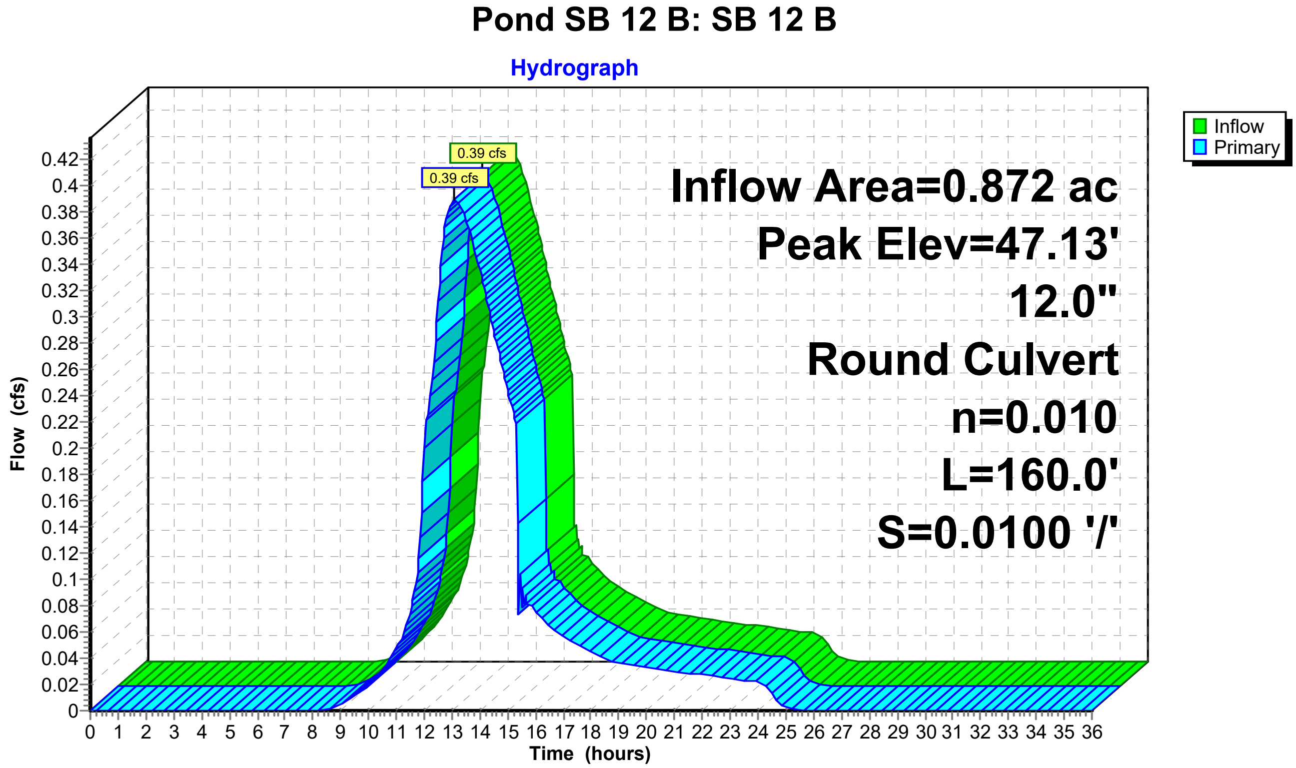
Summary for Pond SB 12 B: SB 12 B

Inflow Area =	0.872 ac,	0.00% Impervious, Inflow Depth = 1.76"	for 2 yr event	
Inflow =	0.39 cfs @	13.09 hrs, Volume=	0.128 af	
Outflow =	0.39 cfs @	13.09 hrs, Volume=	0.128 af,	Atten= 0%, Lag= 0.0 min
Primary =	0.39 cfs @	13.09 hrs, Volume=	0.128 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 47.13' @ 13.05 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	46.80'	**12.0" Round Culvert** L= 160.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 46.80' / 45.20' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=0.39 cfs @ 13.09 hrs HW=47.13' TW=46.34' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 0.39 cfs @ 2.58 fps)

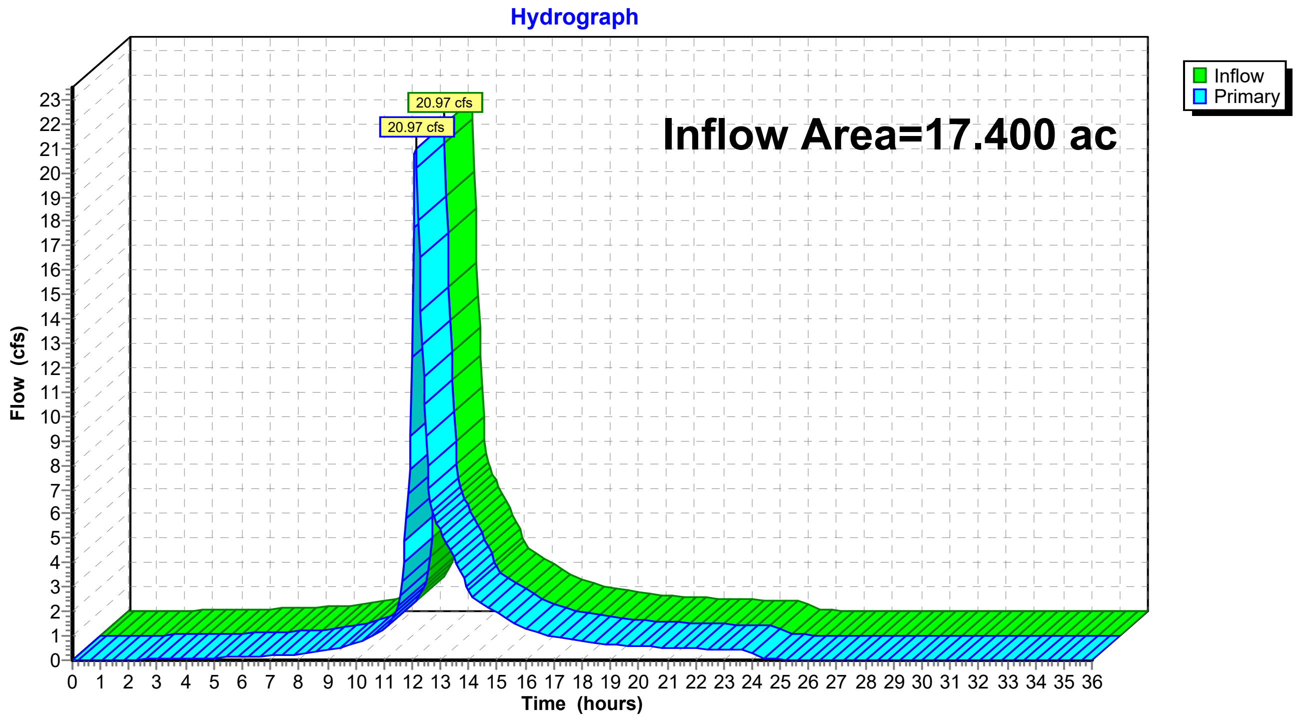


Summary for Link POA: POA

Inflow Area = 17.400 ac, 49.60% Impervious, Inflow Depth > 1.73" for 2 yr event
Inflow = 20.97 cfs @ 12.12 hrs, Volume= 2.510 af
Primary = 20.97 cfs @ 12.12 hrs, Volume= 2.510 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Link POA: POA



Summary for Subcatchment PR-1: PR-1

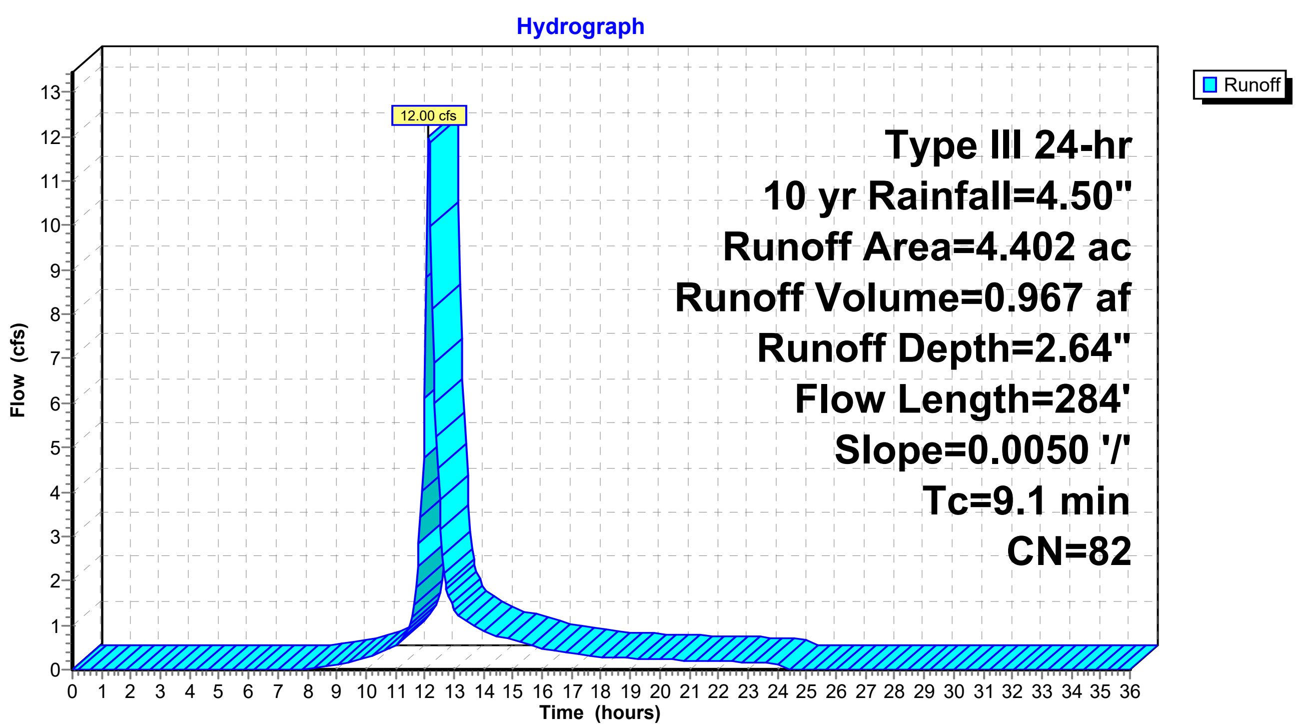
Runoff = 12.00 cfs @ 12.13 hrs, Volume= 0.967 af, Depth= 2.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.50"

Area (ac)	CN	Description
1.892	61	>75% Grass cover, Good, HSG B
2.510	98	Paved parking, HSG B
4.402	82	Weighted Average
1.892		42.98% Pervious Area
2.510		57.02% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	50	0.0050	0.69		**Sheet Flow, A-B**
					Smooth surfaces n= 0.011 P2= 3.20"
7.9	234	0.0050	0.49		**Shallow Concentrated Flow, B-C**
					Short Grass Pasture Kv= 7.0 fps
9.1	284	Total			

Subcatchment PR-1: PR-1



Summary for Subcatchment PR-1A: PR-1A

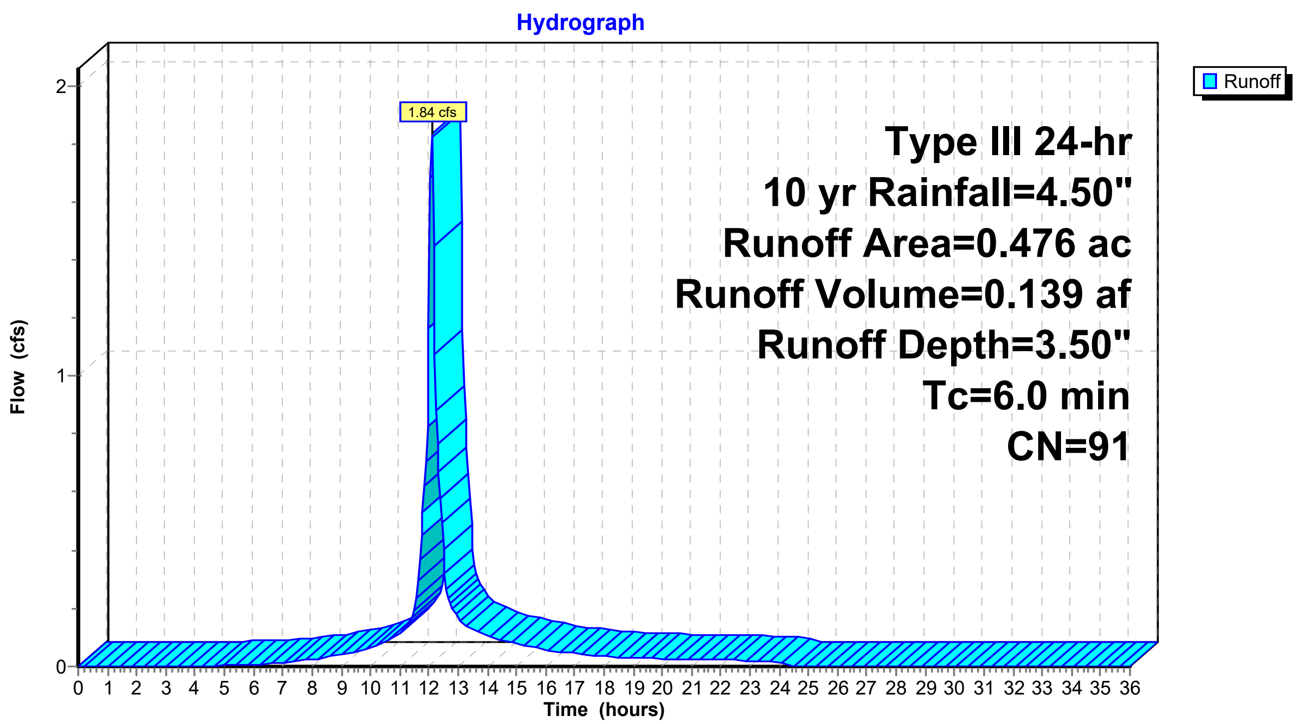
Runoff = 1.84 cfs @ 12.09 hrs, Volume= 0.139 af, Depth= 3.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.50"

Area (ac)	CN	Description
0.090	61	>75% Grass cover, Good, HSG B
0.386	98	Paved parking, HSG B
0.476	91	Weighted Average
0.090		18.91% Pervious Area
0.386		81.09% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-1A: PR-1A



Summary for Subcatchment PR-1B: PR-1B

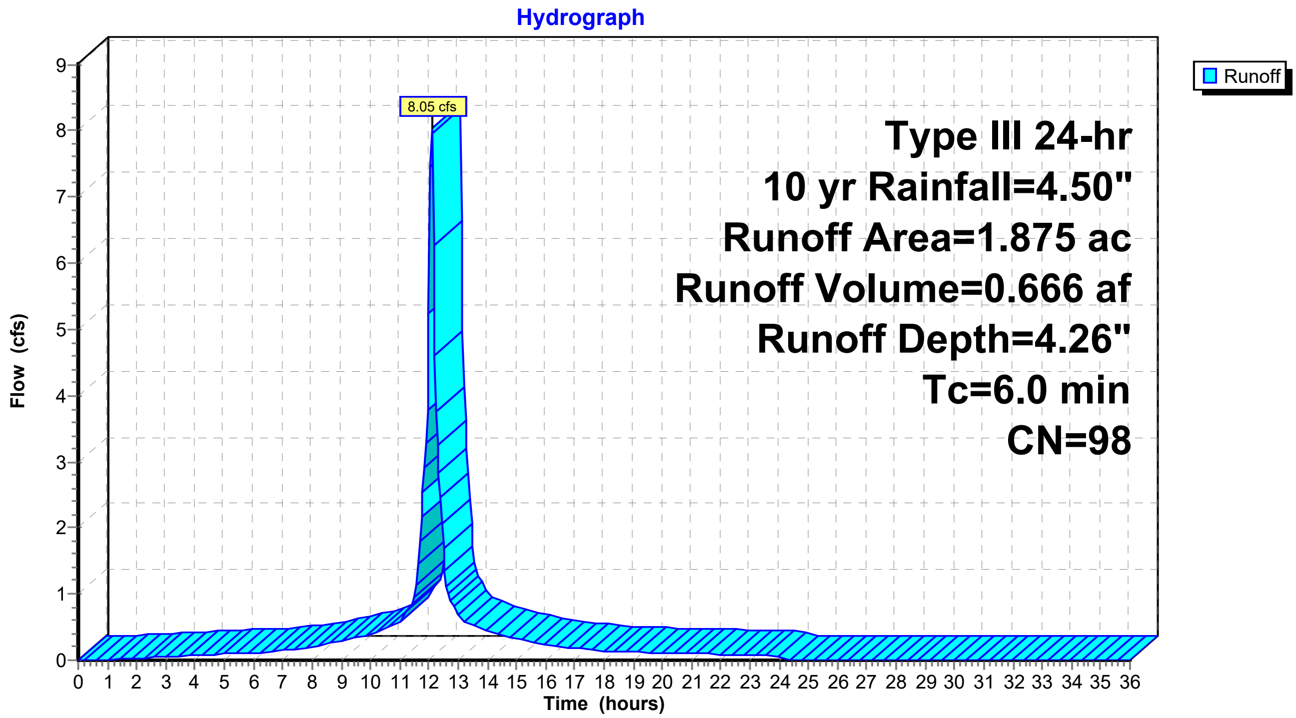
Runoff = 8.05 cfs @ 12.09 hrs, Volume= 0.666 af, Depth= 4.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.50"

Area (ac)	CN	Description
1.875	98	Roofs, HSG B
1.875		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-1B: PR-1B



Summary for Subcatchment PR-1C: PR-1C

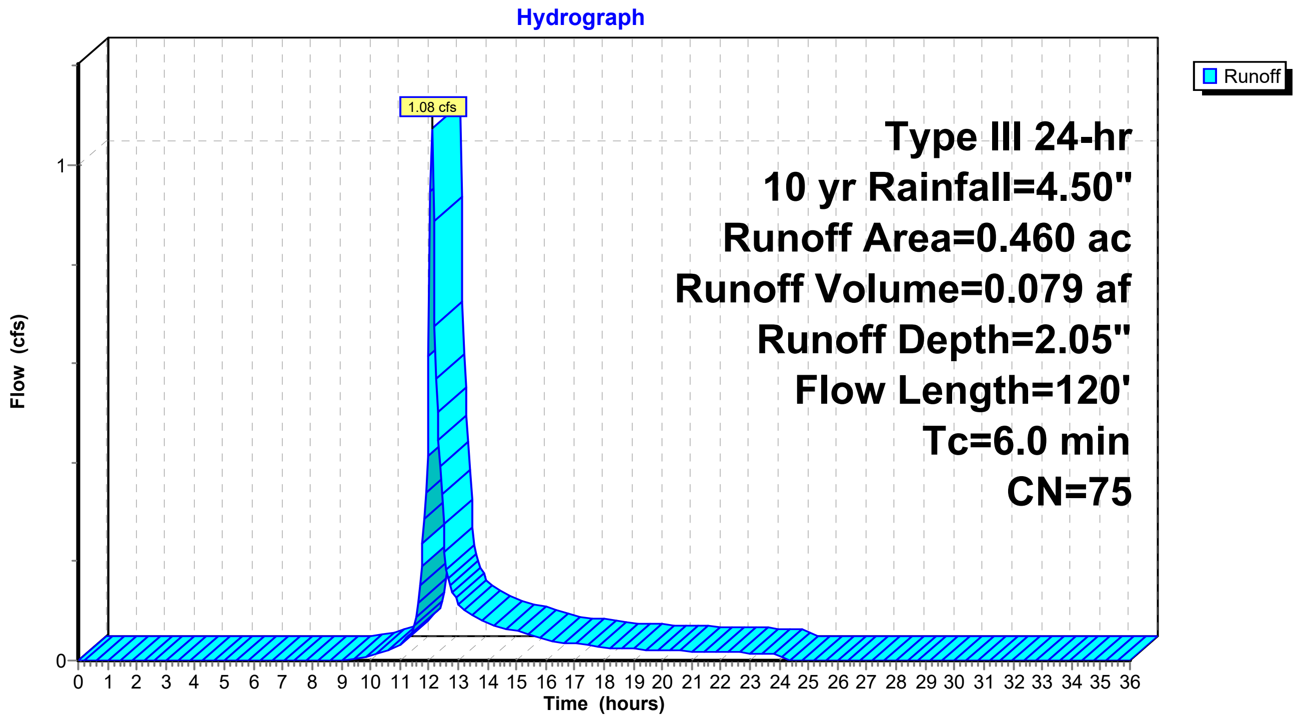
Runoff = 1.08 cfs @ 12.10 hrs, Volume= 0.079 af, Depth= 2.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.50"

Area (ac)	CN	Description
0.020	55	Woods, Good, HSG B
0.260	61	>75% Grass cover, Good, HSG B
0.180	98	Paved parking, HSG B
0.460	75	Weighted Average
0.280		60.87% Pervious Area
0.180		39.13% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	20	0.0700	0.09		**Sheet Flow, 20' SF** Woods: Light underbrush n= 0.400 P2= 3.20"
1.9	40	0.5000	0.35		**Sheet Flow, 30' SF** Grass: Dense n= 0.240 P2= 3.20"
0.1	12	0.0100	1.61		**Shallow Concentrated Flow, 12' SCF** Unpaved Kv= 16.1 fps
0.2	48	0.0400	4.06		**Shallow Concentrated Flow, 48' SCF** Paved Kv= 20.3 fps
5.8	120	Total, Increased to minimum Tc = 6.0 min			

Subcatchment PR-1C: PR-1C



Summary for Subcatchment PR-1D: PR-1D

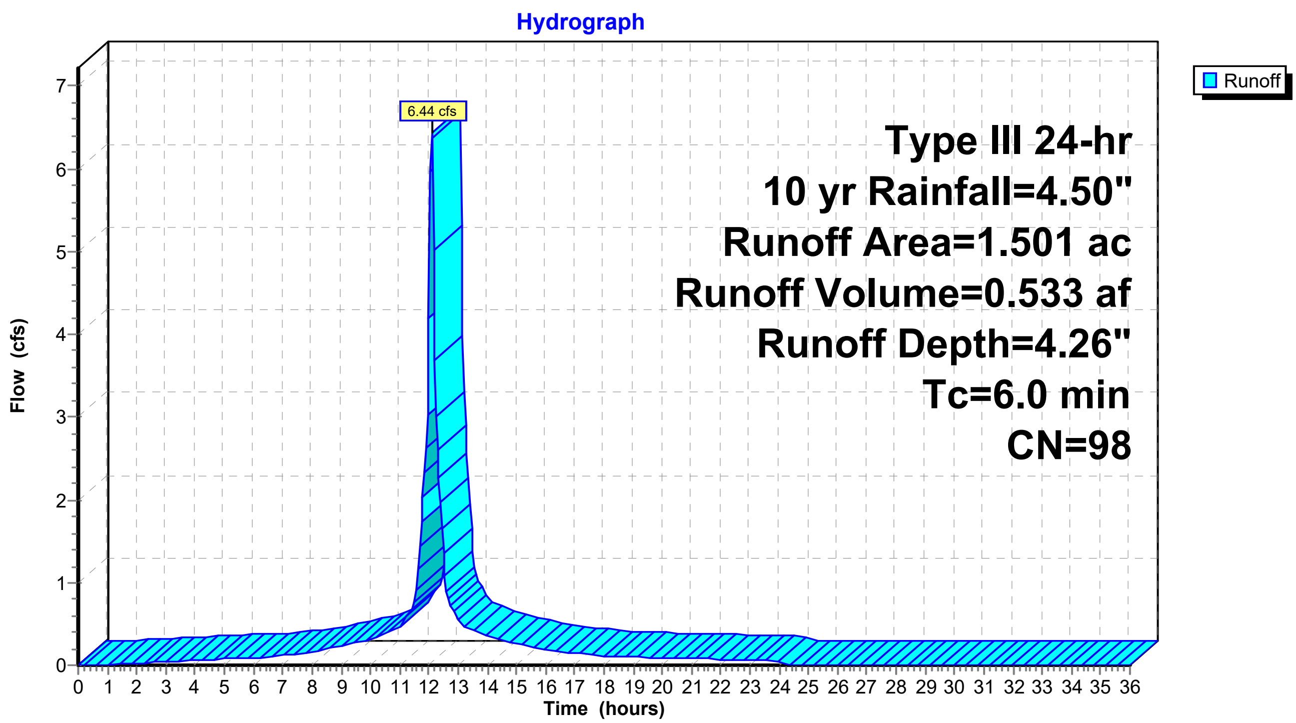
Runoff = 6.44 cfs @ 12.09 hrs, Volume= 0.533 af, Depth= 4.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.50"

Area (ac)	CN	Description
1.501	98	Roofs, HSG B
1.501		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-1D: PR-1D



Summary for Subcatchment PR-1E: PR-1E

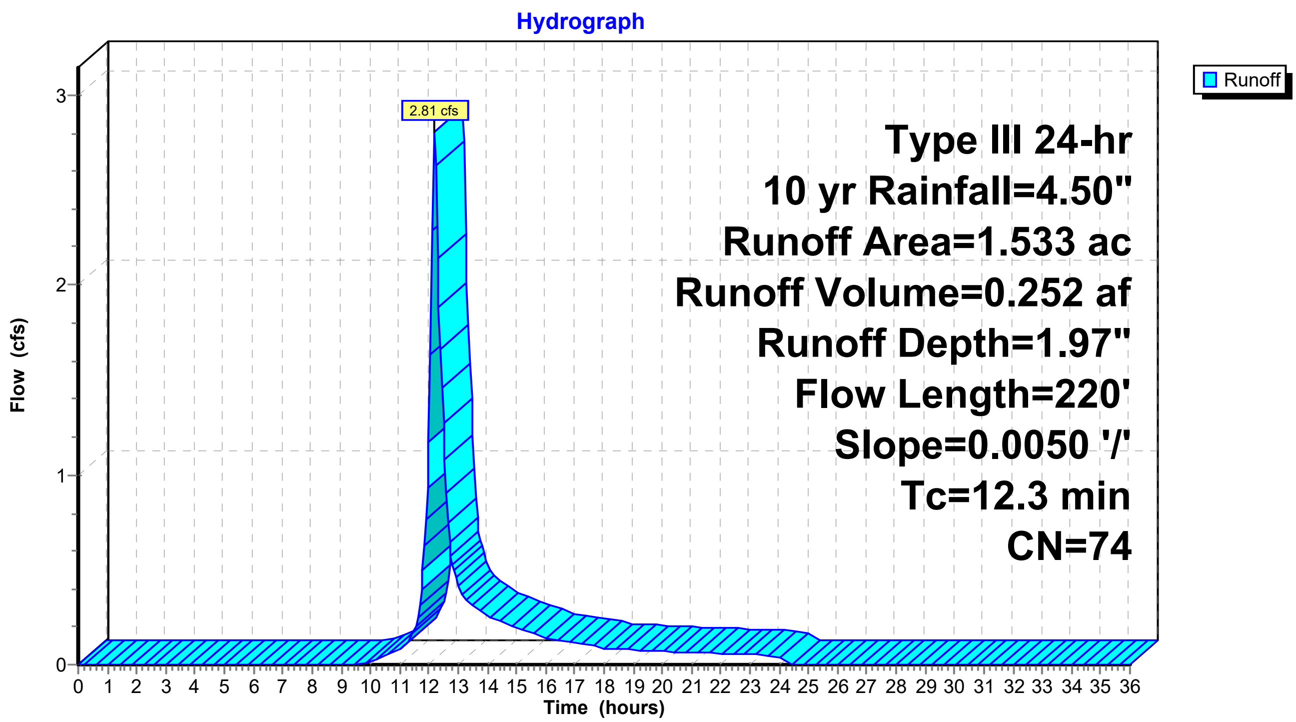
Runoff = 2.81 cfs @ 12.18 hrs, Volume= 0.252 af, Depth= 1.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.50"

Area (ac)	CN	Description
1.000	61	>75% Grass cover, Good, HSG B
0.533	98	Paved parking, HSG B
1.533	74	Weighted Average
1.000		65.23% Pervious Area
0.533		34.77% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.8	50	0.0050	0.09		**Sheet Flow, 50' SF** Grass: Short n= 0.150 P2= 3.20"
2.5	170	0.0050	1.14		**Shallow Concentrated Flow, 170' SCF** Unpaved Kv= 16.1 fps
12.3	220	Total			

Subcatchment PR-1E: PR-1E



Summary for Subcatchment PR-2: PR-2

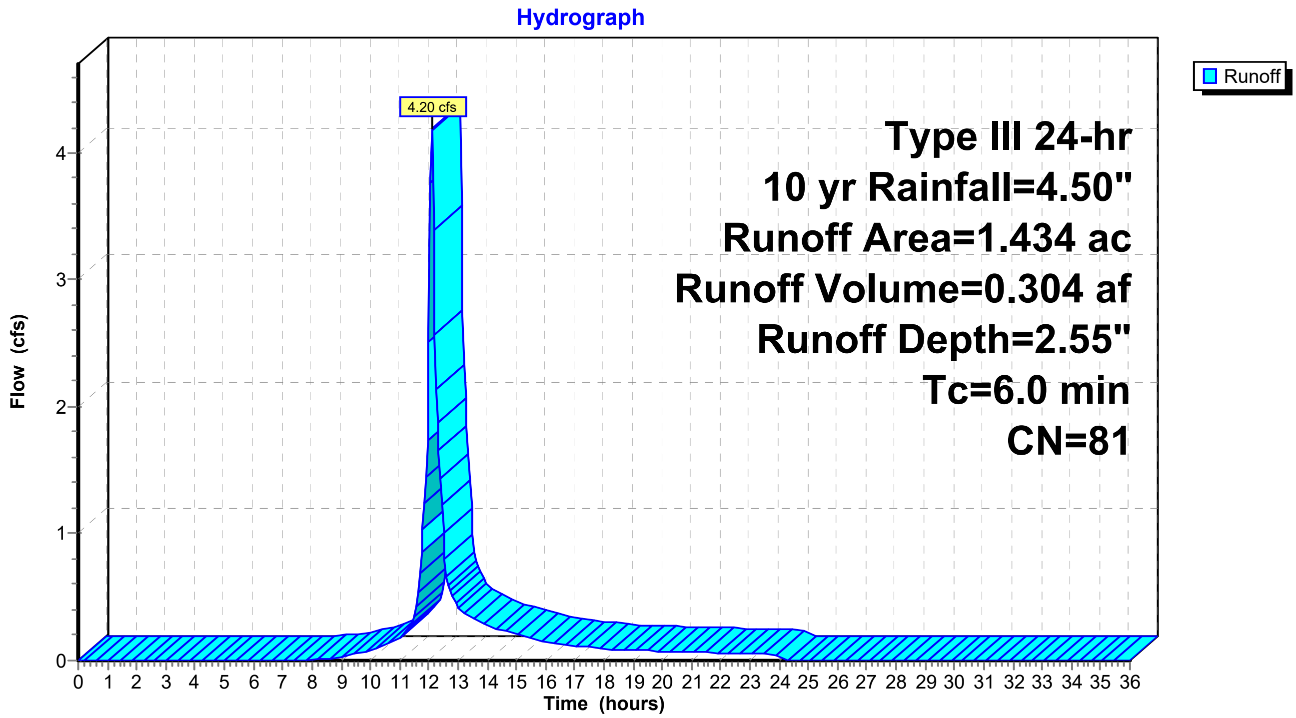
Runoff = 4.20 cfs @ 12.09 hrs, Volume= 0.304 af, Depth= 2.55"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.50"

Area (ac)	CN	Description
0.672	61	>75% Grass cover, Good, HSG B
0.762	98	Paved parking, HSG B
1.434	81	Weighted Average
0.672		46.86% Pervious Area
0.762		53.14% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-2: PR-2



Summary for Subcatchment PR-2A: PR-2B

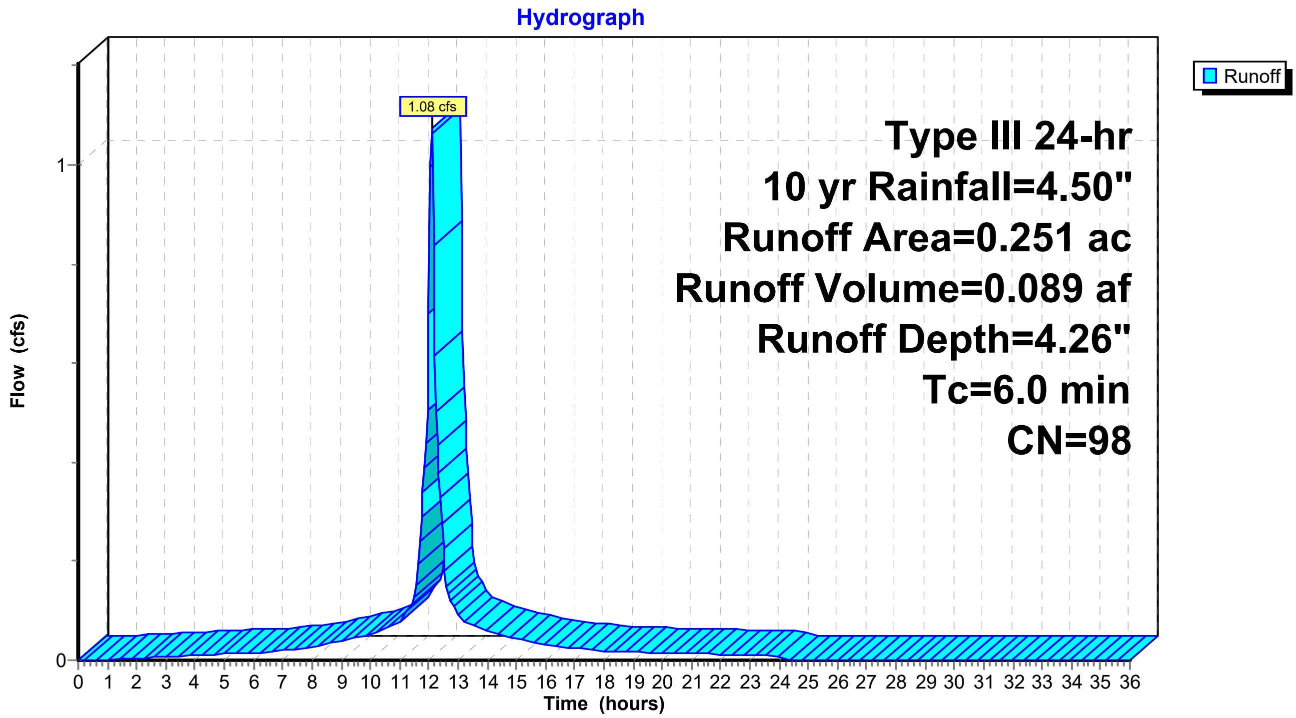
Runoff = 1.08 cfs @ 12.09 hrs, Volume= 0.089 af, Depth= 4.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.50"

Area (ac)	CN	Description
0.251	98	Roofs, HSG B
0.251		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-2A: PR-2B



Summary for Subcatchment PR-3A: PR-3A

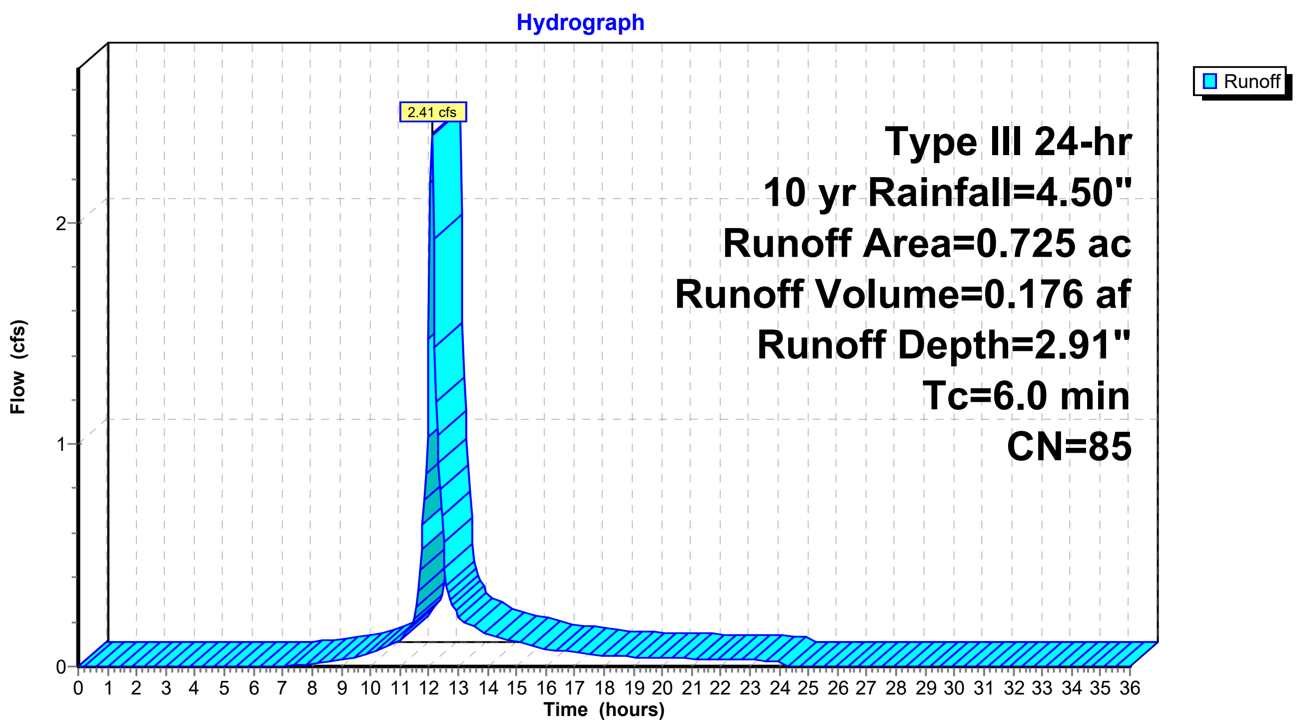
Runoff = 2.41 cfs @ 12.09 hrs, Volume= 0.176 af, Depth= 2.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.50"

Area (ac)	CN	Description
0.249	61	>75% Grass cover, Good, HSG B
0.476	98	Paved parking, HSG B
0.725	85	Weighted Average
0.249		34.34% Pervious Area
0.476		65.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-3A: PR-3A



Summary for Subcatchment PR-3B: PR-3B

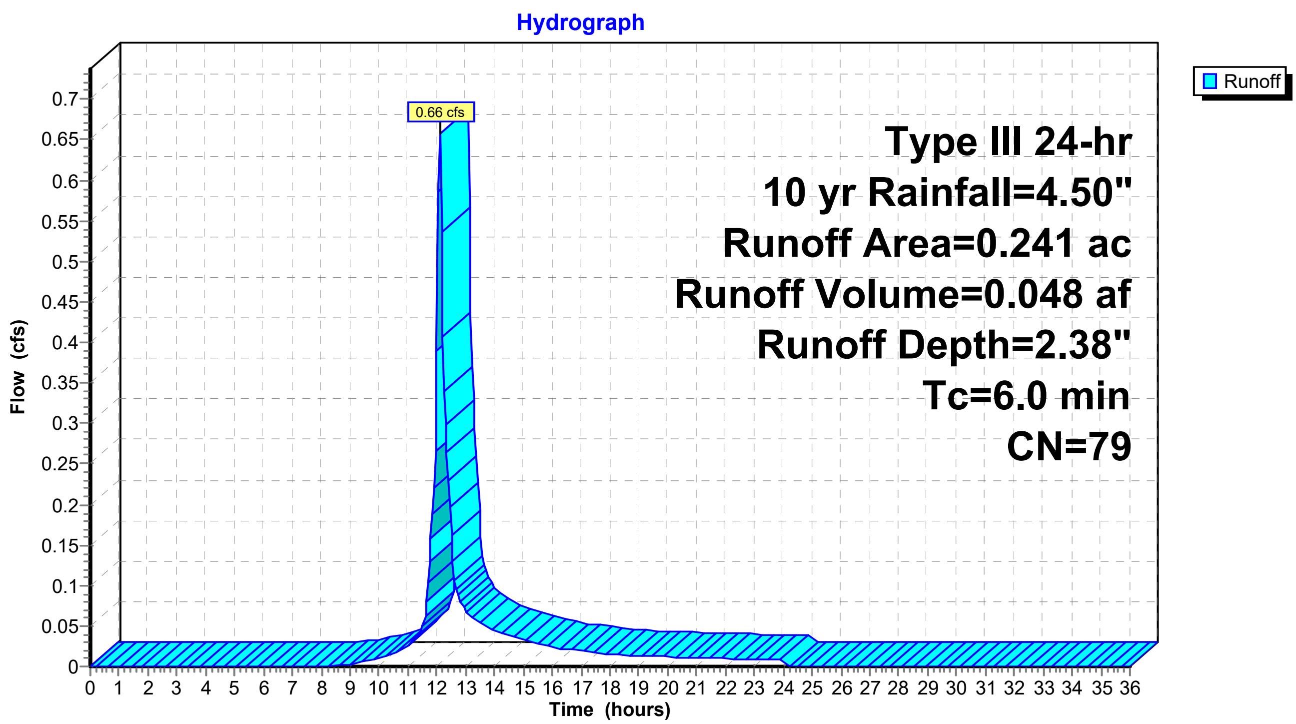
Runoff = 0.66 cfs @ 12.09 hrs, Volume= 0.048 af, Depth= 2.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.50"

Area (ac)	CN	Description
0.124	61	>75% Grass cover, Good, HSG B
0.117	98	Paved parking, HSG B
0.241	79	Weighted Average
0.124		51.45% Pervious Area
0.117		48.55% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-3B: PR-3B



Summary for Subcatchment PR-3C: PR-3C

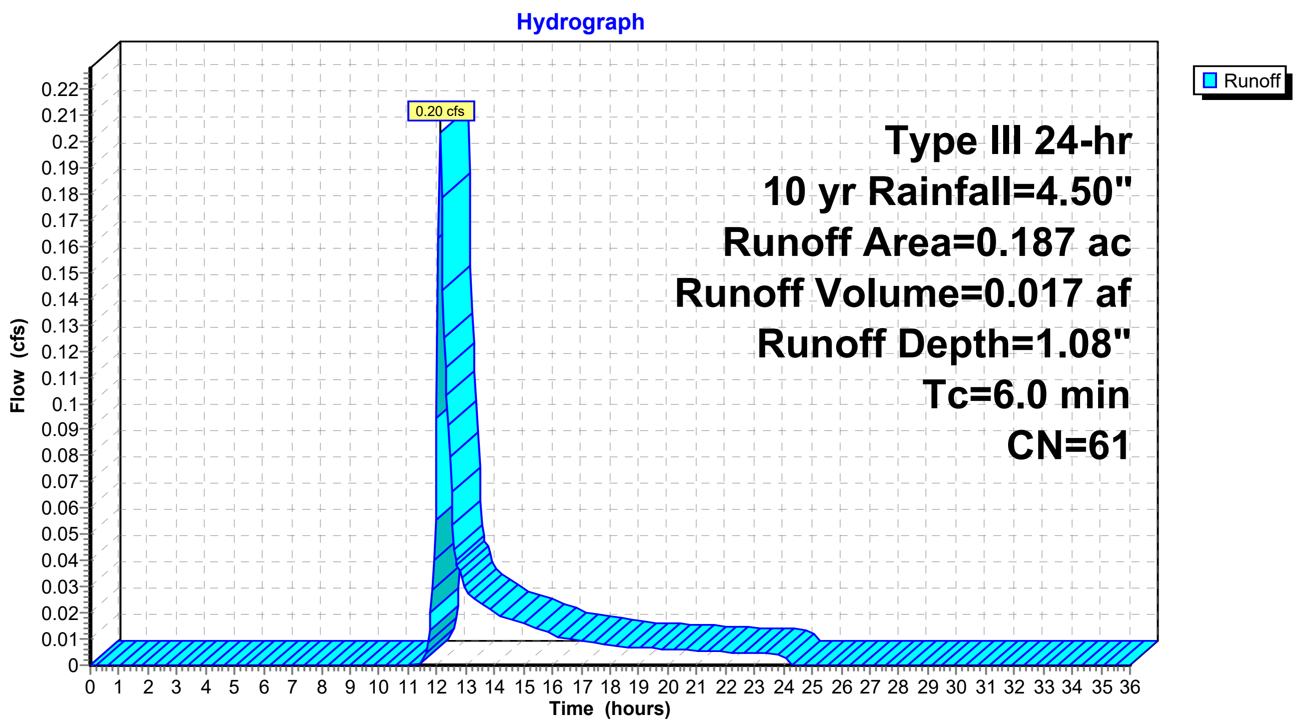
Runoff = 0.20 cfs @ 12.11 hrs, Volume= 0.017 af, Depth= 1.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.50"

Area (ac)	CN	Description
0.187	61	>75% Grass cover, Good, HSG B
0.187		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-3C: PR-3C



Summary for Subcatchment PR-4A: PR-5A

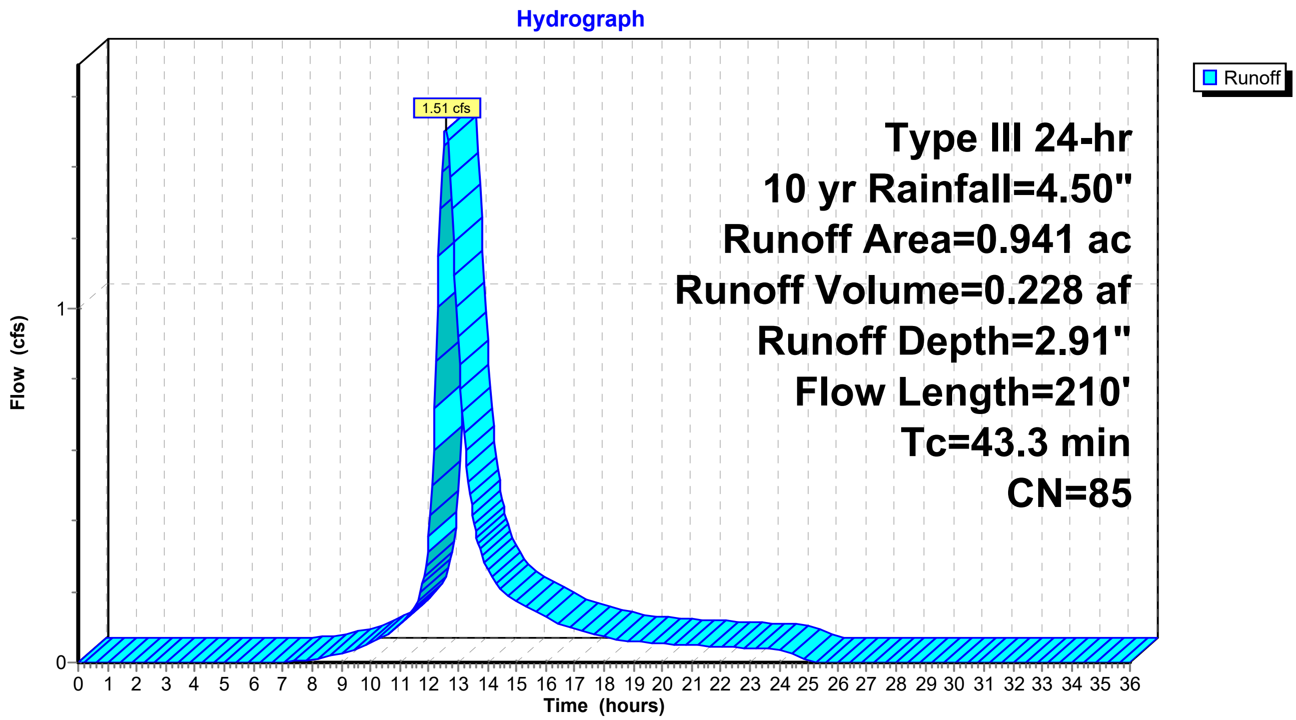
Runoff = 1.51 cfs @ 12.59 hrs, Volume= 0.228 af, Depth= 2.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.50"

	Area (ac)	CN	Description
*	0.941	85	SYNTHETIC TURF- PAD- LINER
	0.941		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
39.6	110	0.0055	0.05		**Sheet Flow, Through Turf Section** Grass: Bermuda n= 0.410 P2= 3.20"
3.7	100	0.0001	0.45	0.16	**Pipe Channel, TRENCH DRAIN LEVEL** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010
43.3	210	Total			

Subcatchment PR-4A: PR-5A



Summary for Subcatchment PR-4B: SB 11 A

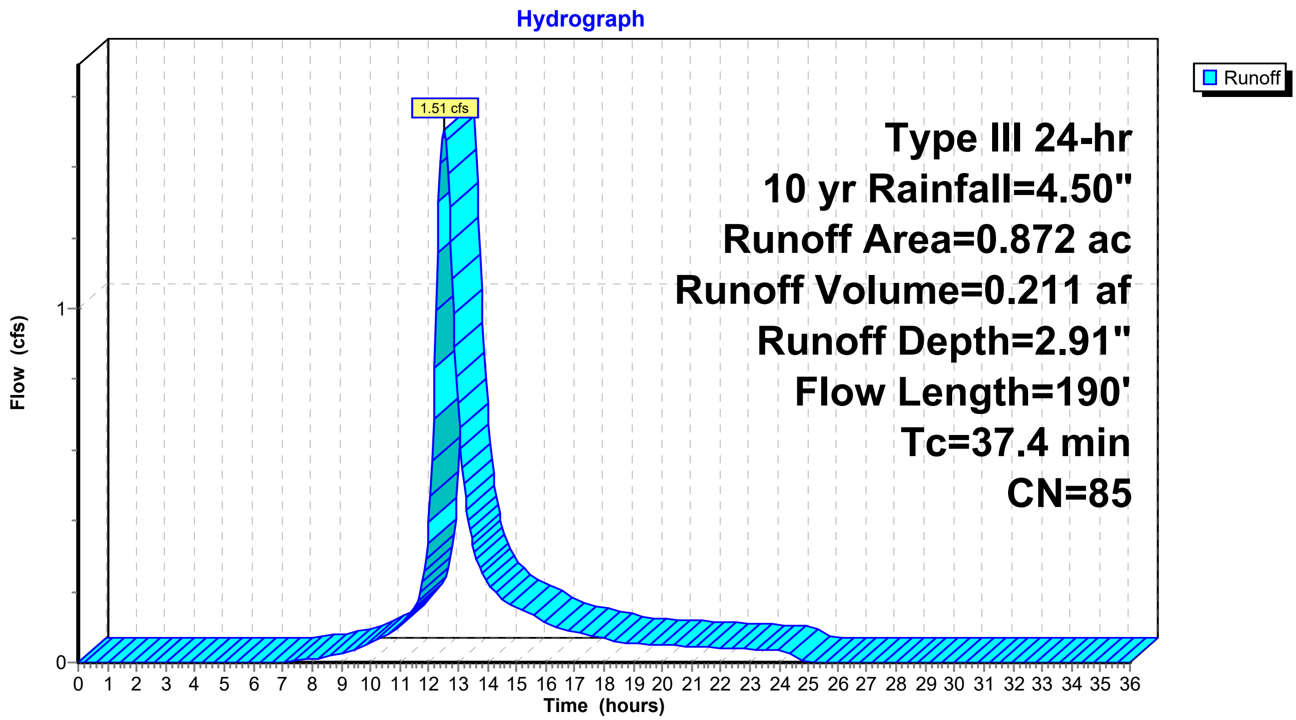
Runoff = 1.51 cfs @ 12.51 hrs, Volume= 0.211 af, Depth= 2.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.50"

	Area (ac)	CN	Description
*	0.872	85	SYNTHETIC TURF- PAD- LINER
	0.872		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
33.7	90	0.0055	0.04		**Sheet Flow, Through Turf Section** Grass: Bermuda n= 0.410 P2= 3.20"
3.7	100	0.0001	0.45	0.16	**Pipe Channel, TRENCH DRAIN LEVEL** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010
37.4	190	Total			

Subcatchment PR-4B: SB 11 A



Summary for Subcatchment PR-4C: SB 00 DPW SLOPE

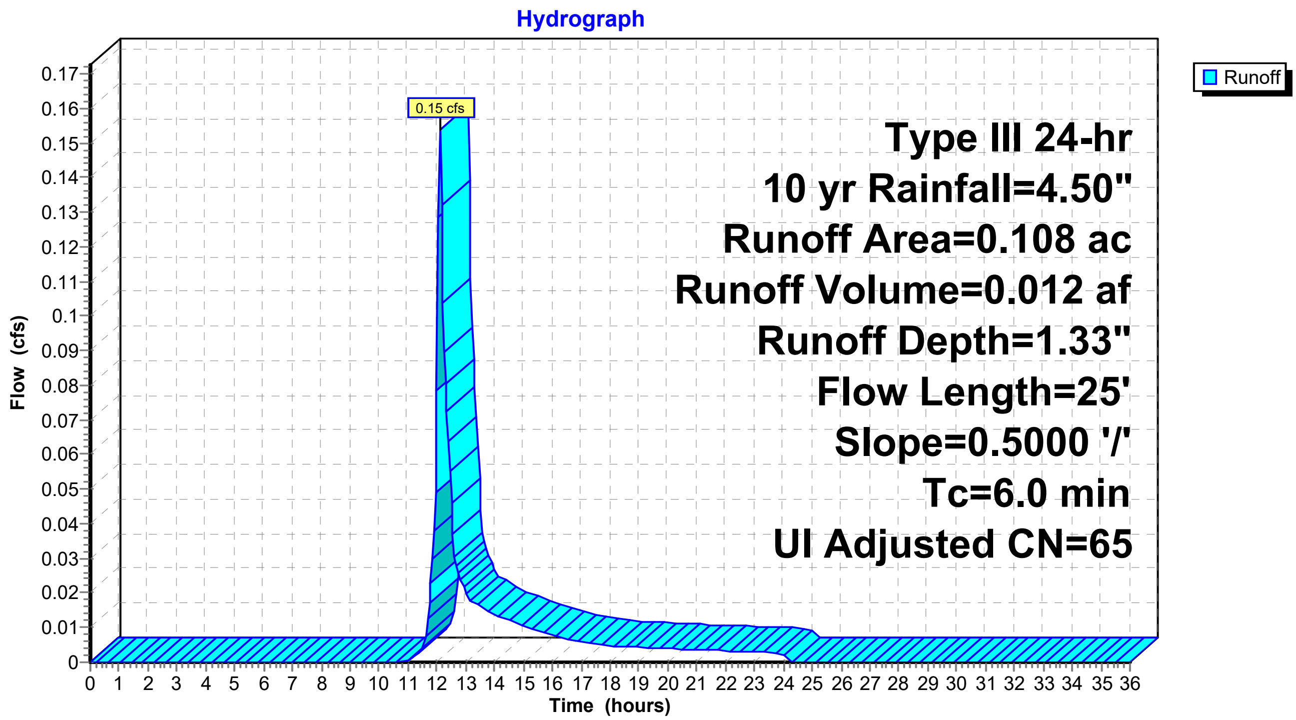
Runoff = 0.15 cfs @ 12.10 hrs, Volume= 0.012 af, Depth= 1.33"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.50"

Area (ac)	CN	Adj	Description
0.025	98		Unconnected pavement, HSG B
0.083	61		>75% Grass cover, Good, HSG B
0.108	70	65	Weighted Average, UI Adjusted
0.083			76.85% Pervious Area
0.025			23.15% Impervious Area
0.025			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.3	25	0.5000	0.32		**Sheet Flow, SLOPING LAND** Grass: Dense n= 0.240 P2= 3.20"
1.3	25	Total, Increased to minimum Tc = 6.0 min			

Subcatchment PR-4C: SB 00 DPW SLOPE



Summary for Subcatchment PR-5A: BB 01 A

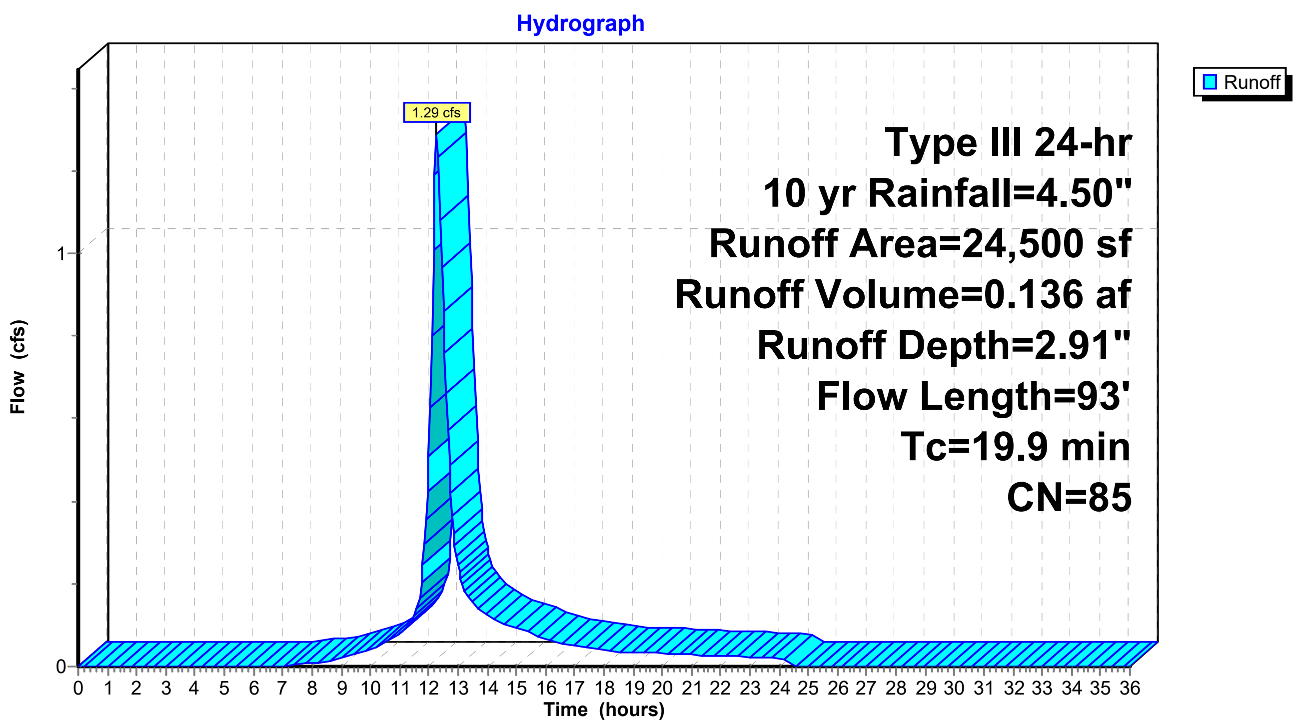
Runoff = 1.29 cfs @ 12.27 hrs, Volume= 0.136 af, Depth= 2.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.50"

	Area (sf)	CN	Description
*	24,500	85	SYNTHETIC TURF- PAD- LINER
	24,500		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.2	46	0.0067	0.04		**Sheet Flow, Through Turf Section** Grass: Bermuda n= 0.410 P2= 3.20"
1.7	47	0.0001	0.45	0.16	**Pipe Channel, TRENCH DRAIN LEVEL** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010
19.9	93	Total			

Subcatchment PR-5A: BB 01 A



Summary for Subcatchment PR-5B: BB 11 A

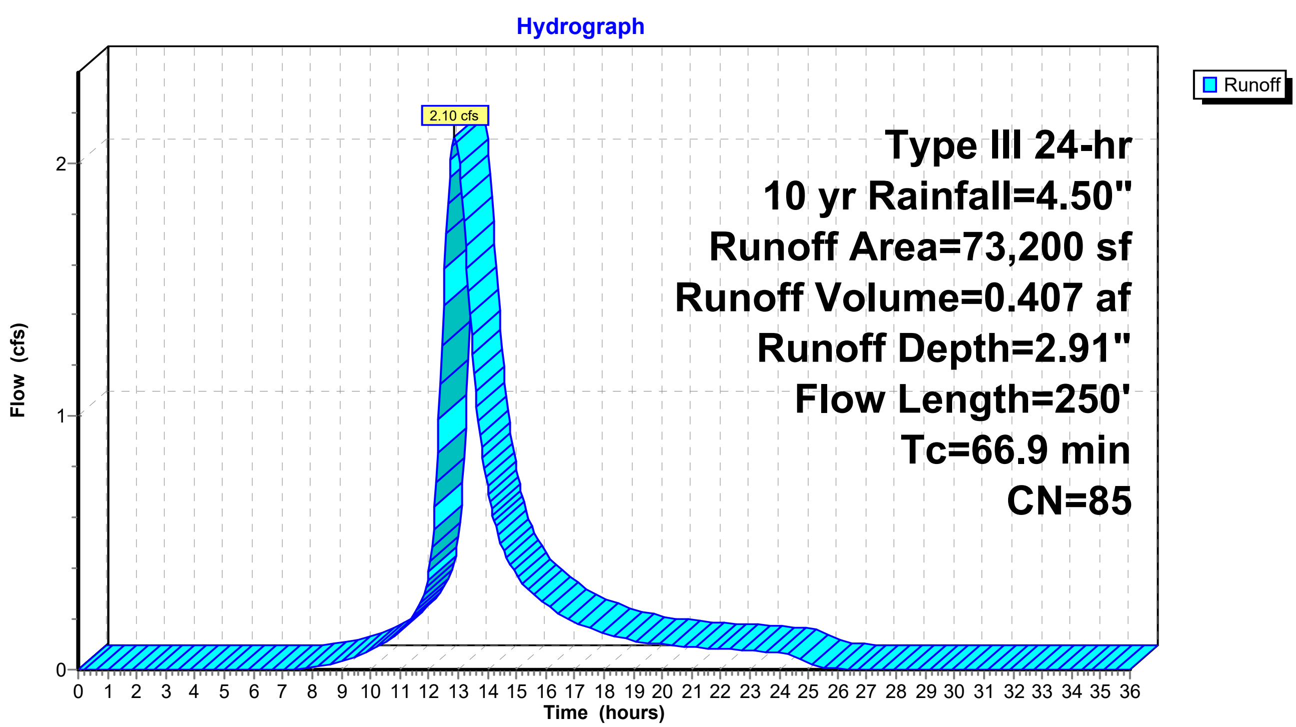
Runoff = 2.10 cfs @ 12.88 hrs, Volume= 0.407 af, Depth= 2.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.50"

	Area (sf)	CN	Description
*	73,200	85	SYNTHETIC TURF- PAD- LINER
	73,200		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.1	53	0.0055	0.04		**Sheet Flow, Through Turf Section** Grass: Bermuda n= 0.410 P2= 3.20"
43.1	150	0.0083	0.06		**Sheet Flow, SYNTHETIC TURF** Grass: Bermuda n= 0.410 P2= 3.20"
1.7	47	0.0001	0.45	0.16	**Pipe Channel, TRENCH DRAIN LEVEL** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010
66.9	250	Total			

Subcatchment PR-5B: BB 11 A

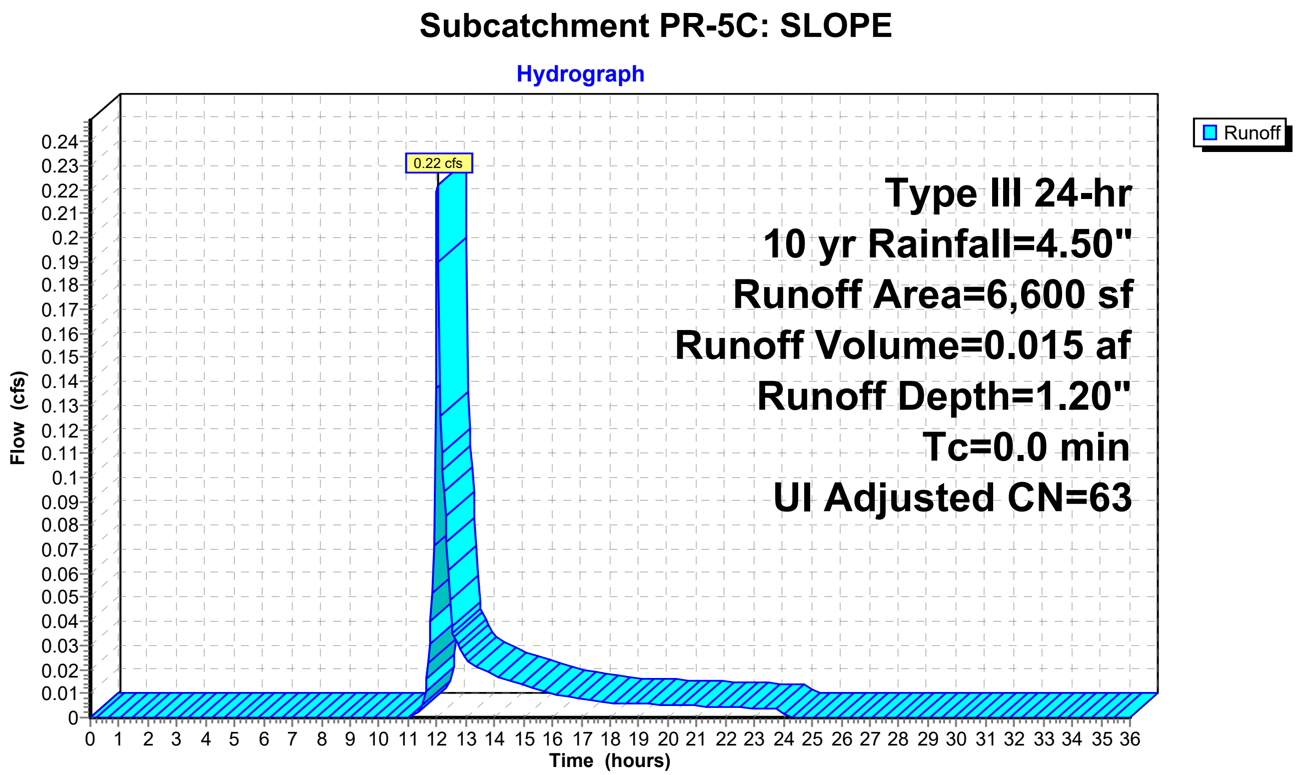


Summary for Subcatchment PR-5C: SLOPE

Runoff = 0.22 cfs @ 12.01 hrs, Volume= 0.015 af, Depth= 1.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=4.50"

Area (sf)	CN	Adj	Description
600	98		Unconnected roofs, HSG B
6,000	61		>75% Grass cover, Good, HSG B
6,600	64	63	Weighted Average, UI Adjusted
6,000			90.91% Pervious Area
600			9.09% Impervious Area
600			100.00% Unconnected



Summary for Pond 1P: rain garden#1 cascading

Inflow Area = 0.725 ac, 65.66% Impervious, Inflow Depth = 2.91" for 10 yr event
Inflow = 2.41 cfs @ 12.09 hrs, Volume= 0.176 af
Outflow = 2.35 cfs @ 12.11 hrs, Volume= 0.174 af, Atten= 2%, Lag= 1.0 min
Primary = 2.35 cfs @ 12.11 hrs, Volume= 0.174 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 61.88' @ 12.11 hrs Surf.Area= 472 sf Storage= 494 cf
Flood Elev= 63.00' Surf.Area= 660 sf Storage= 1,132 cf

Plug-Flow detention time= 49.3 min calculated for 0.174 af (99% of inflow)
Center-of-Mass det. time= 43.5 min (855.2 - 811.7)

Volume	Invert	Avail.Storage	Storage Description
#1	58.50'	1,048 cf	**Rain Garden Envelope (Prismatic)**Listed below (Recalc) 1,348 cf Overall - 300 cf Embedded = 1,048 cf
#2	58.50'	30 cf	**crush stone (Prismatic)**Listed below (Recalc) Inside #1 75 cf Overall x 40.0% Voids
#3	59.00'	50 cf	**Bio Media (Prismatic)**Listed below (Recalc) Inside #1 199 cf Overall x 25.0% Voids
#4	60.33'	5 cf	**Mulch (Prismatic)**Listed below (Recalc) Inside #1 26 cf Overall x 20.0% Voids
		1,132 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
58.50	150	0	0
60.50	150	300	300
61.00	236	97	397
62.00	503	370	766
63.00	660	582	1,348

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
58.50	150	0	0
59.00	150	75	75

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
59.00	150	0	0
60.33	150	199	199

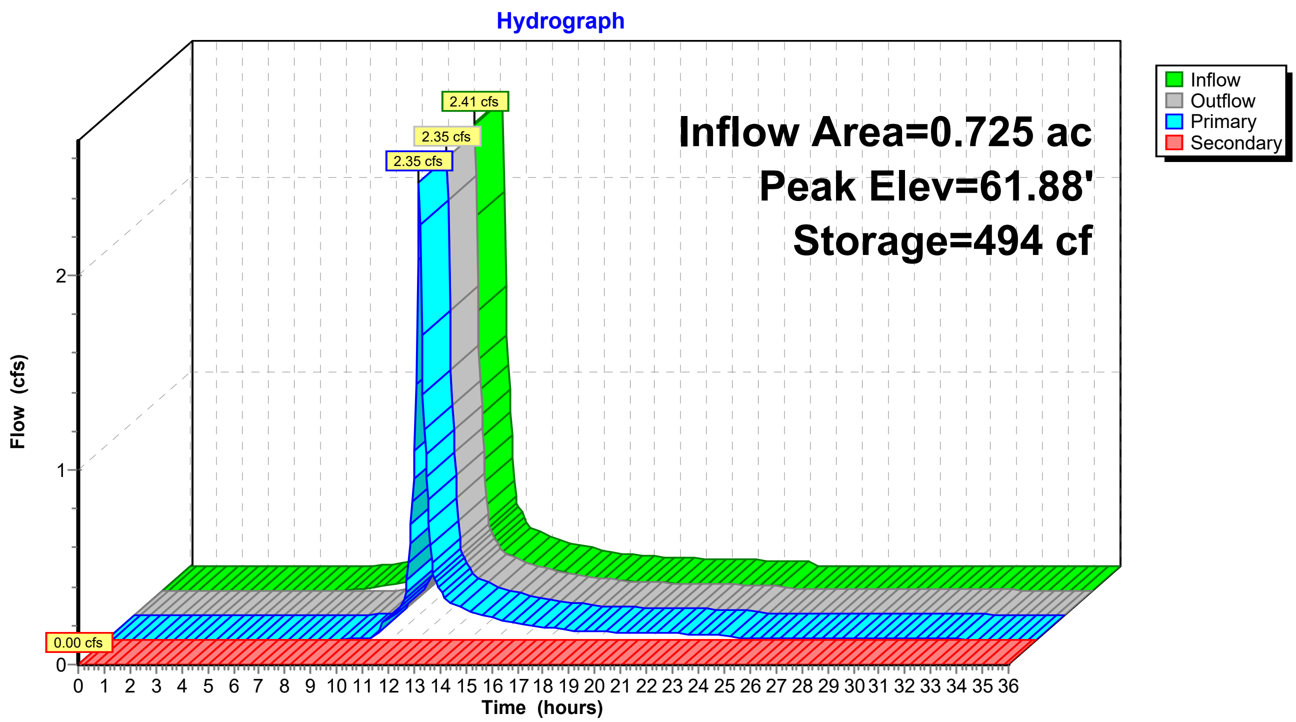
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
60.33	150	0	0
60.50	150	26	26

Device	Routing	Invert	Outlet Devices
#1	Device 3	58.50'	**1.020 in/hr Exfiltration over Surface area**
#2	Secondary	62.00'	**25.0' long x 3.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32
#3	Primary	58.50'	**8.0" Round Culvert** L= 20.0' Ke= 0.500 Inlet / Outlet Invert= 58.50' / 58.40' S= 0.0050 '/' Cc= 0.900 n= 0.012, Flow Area= 0.35 sf
#4	Device 3	61.50'	**12.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=2.33 cfs @ 12.11 hrs HW=61.88' TW=54.20' (Dynamic Tailwater)
└─**3=Culvert** (Passes 2.33 cfs of 2.93 cfs potential flow)
  ├─**1=Exfiltration** (Exfiltration Controls 0.01 cfs)
  └─**4=Orifice/Grate** (Orifice Controls 2.32 cfs @ 2.96 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=58.50' TW=51.00' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)

Pond 1P: rain garden#1 cascading



Summary for Pond 2P: rain garden#2 cascading

Inflow Area = 0.966 ac, 61.39% Impervious, Inflow Depth > 2.75" for 10 yr event
Inflow = 3.01 cfs @ 12.10 hrs, Volume= 0.222 af
Outflow = 2.68 cfs @ 12.15 hrs, Volume= 0.214 af, Atten= 11%, Lag= 2.6 min
Primary = 2.68 cfs @ 12.15 hrs, Volume= 0.214 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 54.25' @ 12.15 hrs Surf.Area= 849 sf Storage= 963 cf
Flood Elev= 55.00' Surf.Area= 1,326 sf Storage= 1,784 cf

Plug-Flow detention time= 73.1 min calculated for 0.214 af (97% of inflow)
Center-of-Mass det. time= 46.0 min (895.5 - 849.6)

Volume	Invert	Avail.Storage	Storage Description
#1	51.00'	1,557 cf	**Rain Garden Envelope (Prismatic)**Listed below (Recalc) 2,357 cf Overall - 800 cf Embedded = 1,557 cf
#2	51.00'	80 cf	**crush stone (Prismatic)**Listed below (Recalc) Inside #1 200 cf Overall x 40.0% Voids
#3	51.50'	133 cf	**Bio Media (Prismatic)**Listed below (Recalc) Inside #1 532 cf Overall x 25.0% Voids
#4	52.83'	14 cf	**Mulch (Prismatic)**Listed below (Recalc) Inside #1 68 cf Overall x 20.0% Voids
		1,784 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
51.00	400	0	0
53.00	400	800	800
54.00	694	547	1,347
55.00	1,326	1,010	2,357

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
51.00	400	0	0
51.50	400	200	200

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
51.50	400	0	0
52.83	400	532	532

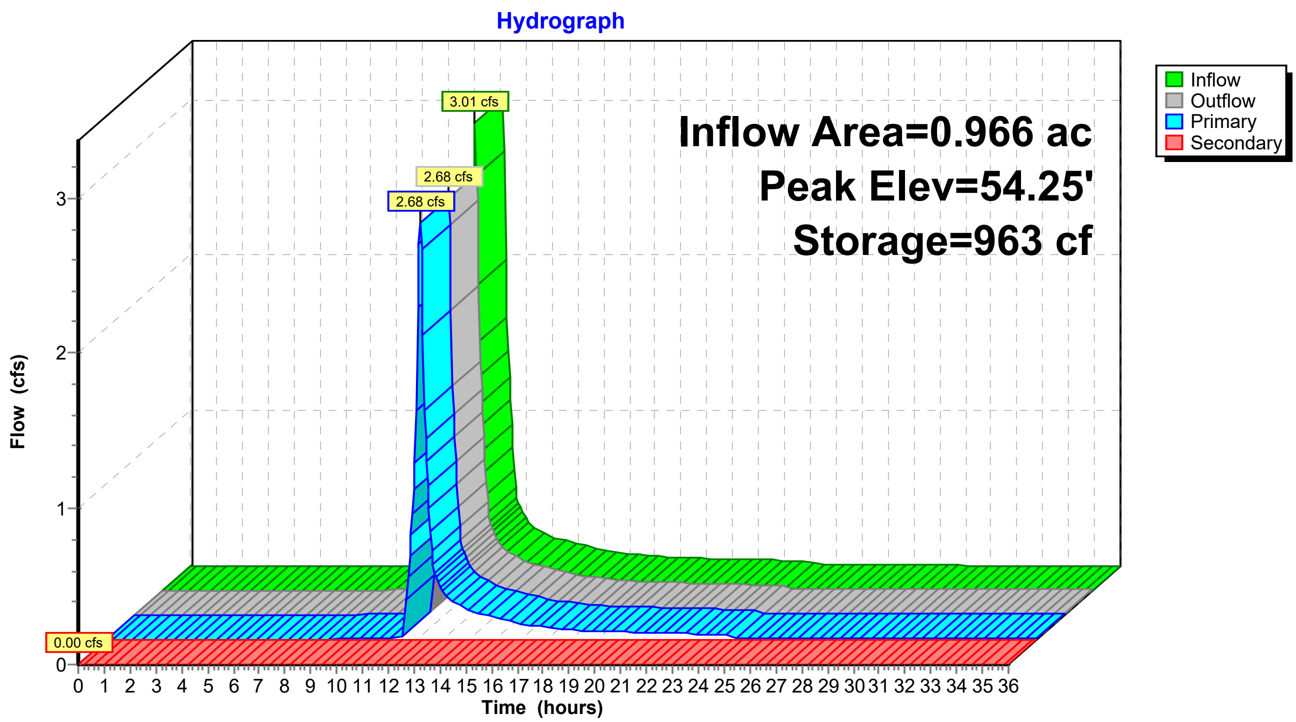
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
52.83	400	0	0
53.00	400	68	68

Device	Routing	Invert	Outlet Devices
#1	Device 3	51.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Secondary	54.50'	**25.0' long x 3.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32
#3	Primary	51.00'	**12.0" Round Culvert** L= 25.0' Ke= 0.500 Inlet / Outlet Invert= 51.00' / 50.88' S= 0.0048 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf
#4	Device 3	53.75'	**12.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=2.68 cfs @ 12.15 hrs HW=54.24' TW=48.92' (Dynamic Tailwater)
└─**3=Culvert** (Passes 2.68 cfs of 6.26 cfs potential flow)
  ├─**1=Exfiltration** (Exfiltration Controls 0.02 cfs)
  └─**4=Orifice/Grate** (Orifice Controls 2.66 cfs @ 3.38 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=51.00' TW=46.00' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)

Pond 2P: rain garden#2 cascading



Summary for Pond 3P: rain garden#3 cascading

Inflow Area = 1.153 ac, 51.43% Impervious, Inflow Depth > 2.41" for 10 yr event
Inflow = 2.86 cfs @ 12.14 hrs, Volume= 0.231 af
Outflow = 2.88 cfs @ 12.15 hrs, Volume= 0.217 af, Atten= 0%, Lag= 0.8 min
Primary = 2.88 cfs @ 12.15 hrs, Volume= 0.217 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 48.92' @ 12.16 hrs Surf.Area= 930 sf Storage= 1,047 cf
Flood Elev= 50.00' Surf.Area= 1,373 sf Storage= 2,283 cf

Plug-Flow detention time= 101.5 min calculated for 0.217 af (94% of inflow)
Center-of-Mass det. time= 45.1 min (939.5 - 894.4)

Volume	Invert	Avail.Storage	Storage Description
#1	46.00'	1,944 cf	**Rain Garden Envelope (Prismatic)** Listed below (Recalc) 3,144 cf Overall - 1,200 cf Embedded = 1,944 cf
#2	46.00'	120 cf	**crush stone (Prismatic)** Listed below (Recalc) Inside #1 300 cf Overall x 40.0% Voids
#3	46.50'	199 cf	**Bio Media (Prismatic)** Listed below (Recalc) Inside #1 798 cf Overall x 25.0% Voids
#4	47.83'	20 cf	**Mulch (Prismatic)** Listed below (Recalc) Inside #1 102 cf Overall x 20.0% Voids
		2,283 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
46.00	600	0	0
48.00	600	1,200	1,200
49.00	957	779	1,979
50.00	1,373	1,165	3,144

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
46.00	600	0	0
46.50	600	300	300

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
46.50	600	0	0
47.83	600	798	798

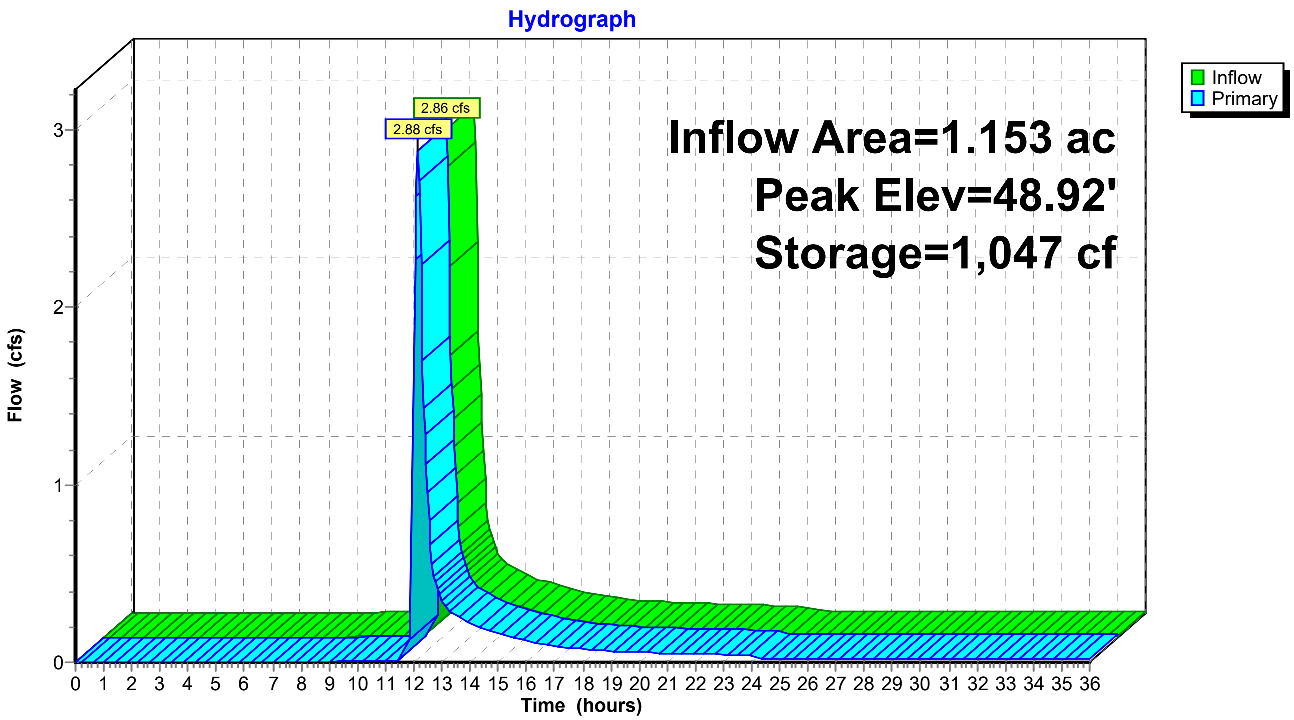
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
47.83	600	0	0
48.00	600	102	102

Device	Routing	Invert	Outlet Devices
#1	Device 3	46.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Device 3	48.75'	**24.0" x 48.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

#3	Primary	46.00'	**15.0" Round Culvert** L= 26.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 46.00' / 45.87' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf

Primary OutFlow Max=2.86 cfs @ 12.15 hrs HW=48.92' TW=0.00' (Dynamic Tailwater)
└─**3=Culvert** (Passes 2.86 cfs of 7.07 cfs potential flow)
  ├─**1=Exfiltration** (Exfiltration Controls 0.02 cfs)
  └─**2=Orifice/Grate** (Weir Controls 2.84 cfs @ 1.36 fps)

Pond 3P: rain garden#3 cascading



Summary for Pond 4P: UGS-1

Inflow Area = 1.685 ac, 60.12% Impervious, Inflow Depth = 2.80" for 10 yr event
Inflow = 5.27 cfs @ 12.09 hrs, Volume= 0.394 af
Outflow = 4.30 cfs @ 12.15 hrs, Volume= 0.373 af, Atten= 18%, Lag= 3.7 min
Discarded = 0.04 cfs @ 9.00 hrs, Volume= 0.098 af
Primary = 4.26 cfs @ 12.15 hrs, Volume= 0.275 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 42.88' @ 12.15 hrs Surf.Area= 1,672 sf Storage= 3,764 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 130.7 min (937.6 - 806.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	39.50'	2,099 cf	**29.92'W x 55.89'L x 5.50'H Field A** 9,196 cf Overall - 3,198 cf Embedded = 5,998 cf x 35.0% Voids
#2A	40.25'	3,198 cf	**ADS_StormTech MC-3500 d +Cap** x 28 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap 28 Chambers in 4 Rows Cap Storage= +14.9 cf x 2 x 4 rows = 119.2 cf
		5,297 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	39.50'	**24.0" Round Culvert** L= 50.0' Ke= 0.500 Inlet / Outlet Invert= 39.50' / 39.00' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf
#2	Device 1	43.60'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Discarded	39.50'	**1.020 in/hr Exfiltration over Surface area**
#4	Device 1	41.83'	**8.0" Vert. Orifice/Grate X 3.00** C= 0.600

Discarded OutFlow Max=0.04 cfs @ 9.00 hrs HW=39.56' (Free Discharge)
└─**3=Exfiltration** (Exfiltration Controls 0.04 cfs)

Primary OutFlow Max=4.24 cfs @ 12.15 hrs HW=42.87' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Passes 4.24 cfs of 23.30 cfs potential flow)
  ├─**2=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)
  └─**4=Orifice/Grate** (Orifice Controls 4.24 cfs @ 4.05 fps)

Pond 4P: UGS-1 - Chamber Wizard Field A

Chamber Model = ADS_StormTechMC-3500 d +Cap (ADS StormTech®MC-3500 d rev 03/14 with Cap volume)
Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf
Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap
Cap Storage= +14.9 cf x 2 x 4 rows = 119.2 cf

77.0" Wide + 9.0" Spacing = 86.0" C-C Row Spacing

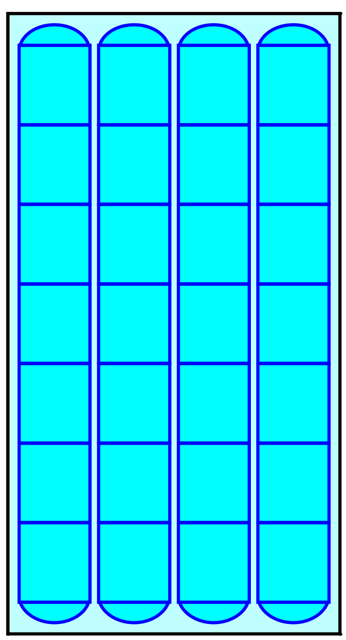
7 Chambers/Row x 7.17' Long +1.85' Cap Length x 2 = 53.89' Row Length +12.0" End Stone x 2 = 55.89' Base Length
4 Rows x 77.0" Wide + 9.0" Spacing x 3 + 12.0" Side Stone x 2 = 29.92' Base Width
9.0" Base + 45.0" Chamber Height + 12.0" Cover = 5.50' Field Height

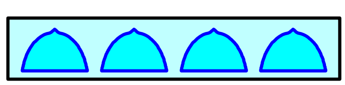
28 Chambers x 110.0 cf + 14.9 cf Cap Volume x 2 x 4 Rows = 3,197.9 cf Chamber Storage

9,196.2 cf Field - 3,197.9 cf Chambers = 5,998.4 cf Stone x 35.0% Voids = 2,099.4 cf Stone Storage

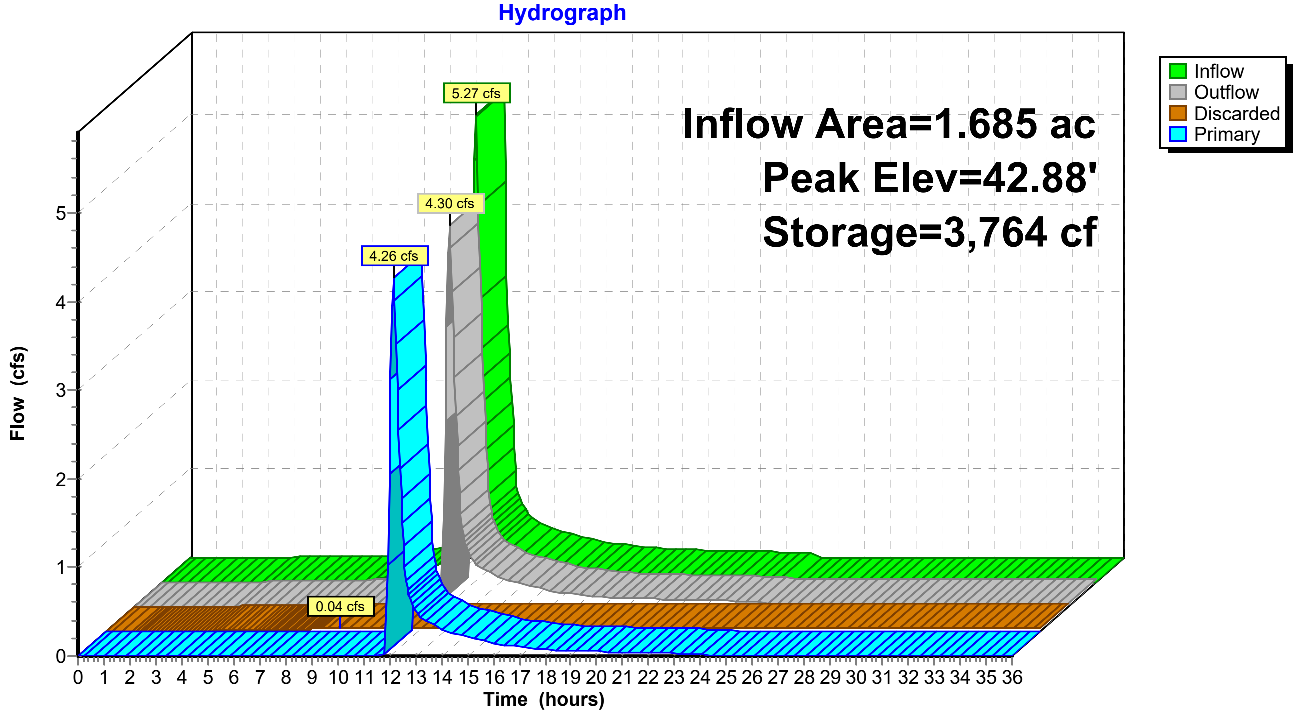
Chamber Storage + Stone Storage = 5,297.3 cf = 0.122 af
Overall Storage Efficiency = 57.6%
Overall System Size = 55.89' x 29.92' x 5.50'

28 Chambers
340.6 cy Field
222.2 cy Stone





Pond 4P: UGS-1


Hydrograph
Inflow
Outflow
Discarded
Primary
5.27 cfs
4.30 cfs
4.26 cfs
0.04 cfs
Inflow Area=1.685 ac
Peak Elev=42.88'
Storage=3,764 cf
Flow (cfs)
0
1
2
3
4
5
Time (hours)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36

Summary for Pond BB 01 B: BB 01 B

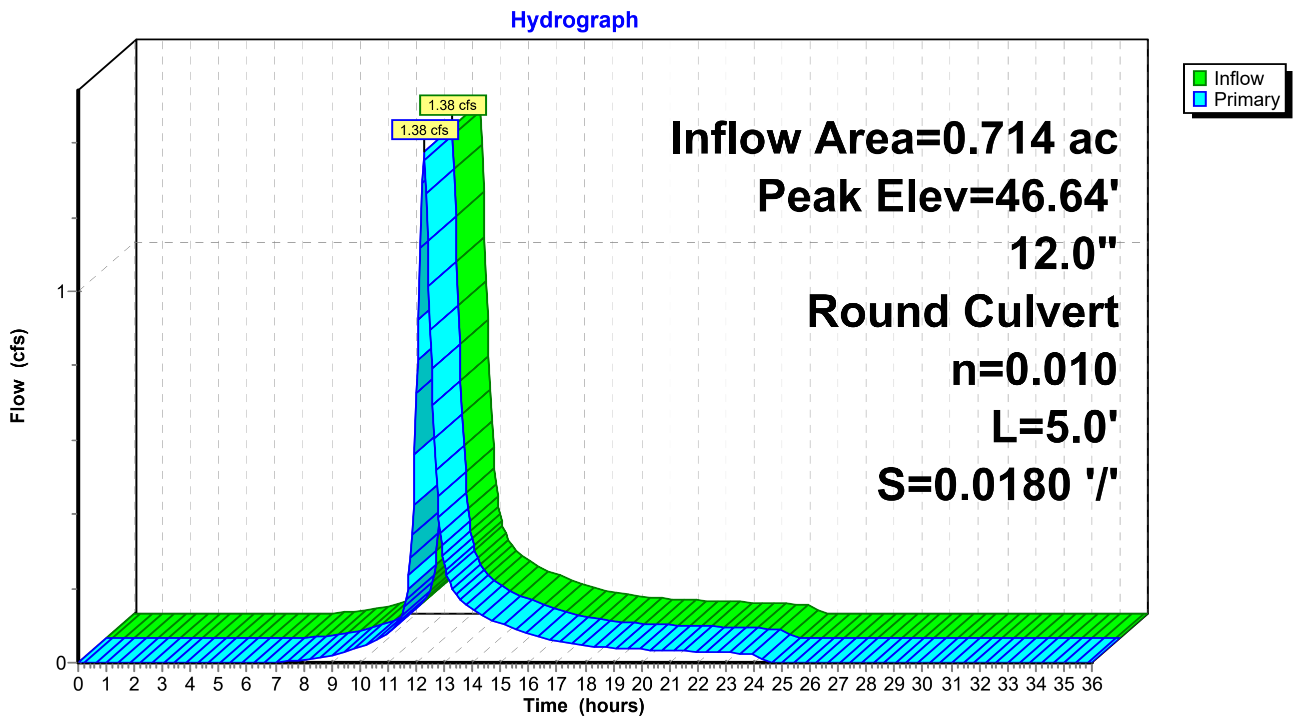
Inflow Area =	0.714 ac,	1.93% Impervious, Inflow Depth = 2.55"	for 10 yr event	
Inflow =	1.38 cfs @	12.27 hrs, Volume=	0.152 af	
Outflow =	1.38 cfs @	12.27 hrs, Volume=	0.152 af,	Atten= 0%, Lag= 0.0 min
Primary =	1.38 cfs @	12.27 hrs, Volume=	0.152 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 46.64' @ 12.65 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	45.90'	**12.0" Round Culvert** L= 5.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 45.90' / 45.81' S= 0.0180 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=1.37 cfs @ 12.27 hrs HW=46.60' TW=46.19' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 1.37 cfs @ 3.28 fps)

Pond BB 01 B: BB 01 B



Summary for Pond BB 01 S: BB 01 S

Inflow Area = 0.714 ac, 1.93% Impervious, Inflow Depth = 2.55" for 10 yr event
Inflow = 1.38 cfs @ 12.27 hrs, Volume= 0.152 af
Outflow = 0.58 cfs @ 12.66 hrs, Volume= 0.152 af, Atten= 58%, Lag= 23.8 min
Primary = 0.58 cfs @ 12.66 hrs, Volume= 0.152 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 46.60' @ 12.67 hrs Surf.Area= 0 sf Storage= 1,600 cf

Plug-Flow detention time= 23.5 min calculated for 0.151 af (100% of inflow)
Center-of-Mass det. time= 23.5 min (852.5 - 829.0)

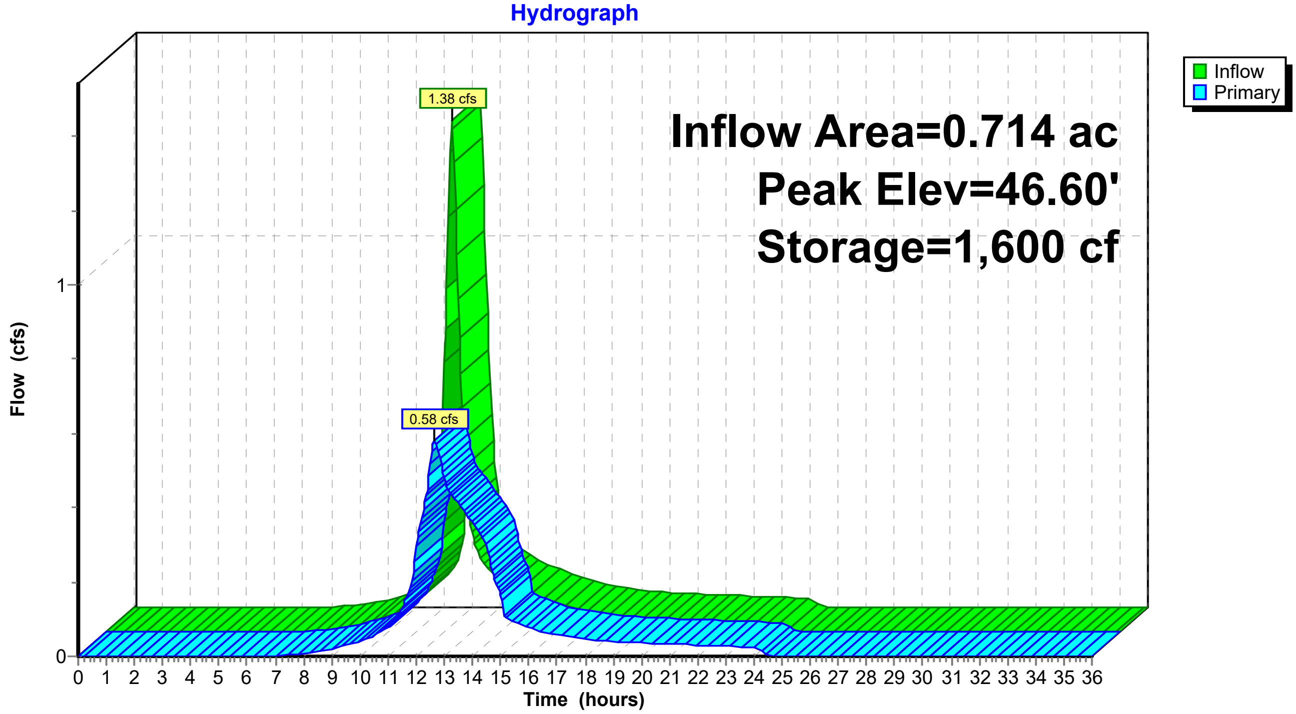
Volume	Invert	Avail.Storage	Storage Description
#1	44.97'	3,256 cf	**Custom Stage Data** Listed below

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
44.97	0	0
45.30	16	16
45.80	236	252
46.30	825	1,077
46.80	876	1,953
47.30	792	2,745
47.80	511	3,256

Device	Routing	Invert	Outlet Devices
#1	Primary	44.97'	**4.0" Round Culvert** L= 8.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 44.97' / 44.87' S= 0.0125 '/' Cc= 0.900 n= 0.010, Flow Area= 0.09 sf
#2	Primary	46.40'	**6.0" Round Culvert** L= 5.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 46.40' / 46.30' S= 0.0200 '/' Cc= 0.900 n= 0.010, Flow Area= 0.20 sf

Primary OutFlow Max=0.58 cfs @ 12.66 hrs HW=46.60' TW=45.35' (Dynamic Tailwater)
—**1=Culvert** (Inlet Controls 0.47 cfs @ 5.38 fps)
—**2=Culvert** (Inlet Controls 0.11 cfs @ 1.51 fps)

Pond BB 01 S: BB 01 S



Summary for Pond BB 06 B: BB 06 B

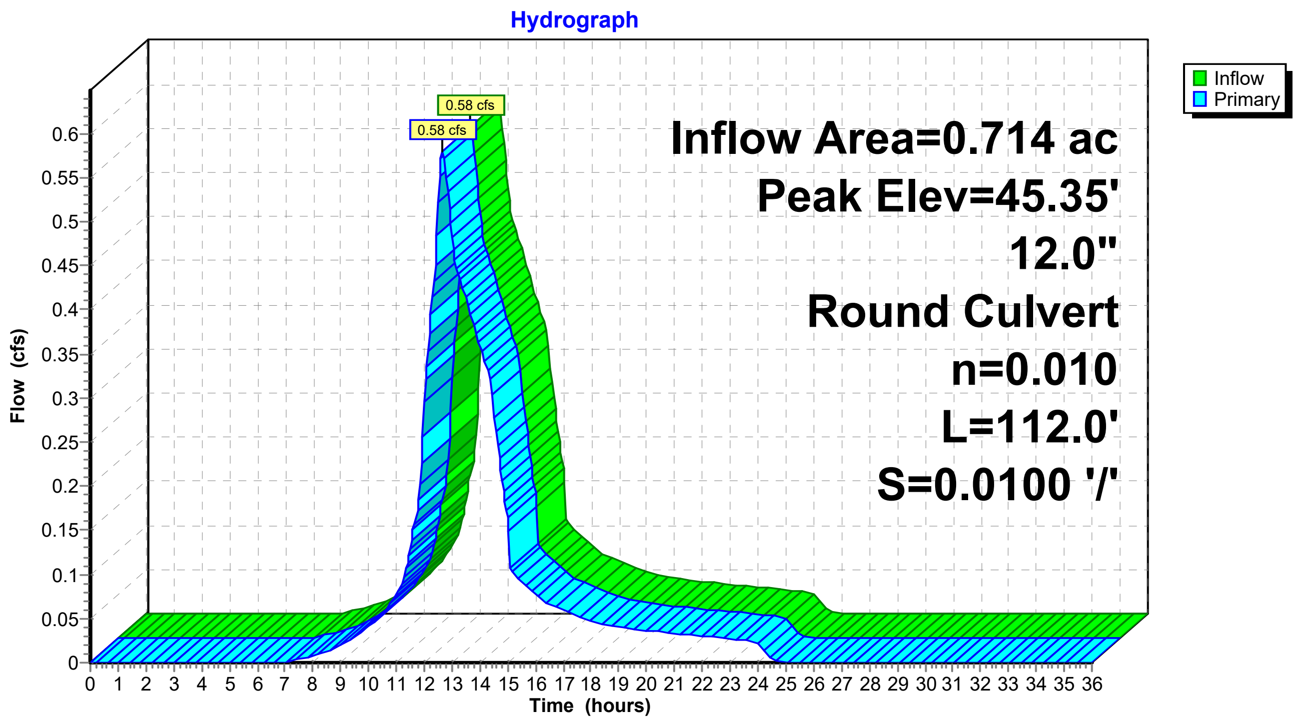
Inflow Area =	0.714 ac,	1.93% Impervious,	Inflow Depth = 2.55"	for 10 yr event	
Inflow =	0.58 cfs @	12.66 hrs,	Volume=	0.152 af	
Outflow =	0.58 cfs @	12.66 hrs,	Volume=	0.152 af,	Atten= 0%, Lag= 0.0 min
Primary =	0.58 cfs @	12.66 hrs,	Volume=	0.152 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 45.35' @ 12.66 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	44.97'	**12.0" Round Culvert** L= 112.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 44.97' / 43.85' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=0.58 cfs @ 12.66 hrs HW=45.35' TW=43.14' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 0.58 cfs @ 2.10 fps)

Pond BB 06 B: BB 06 B



Summary for Pond BB 11 B: BB 11 B

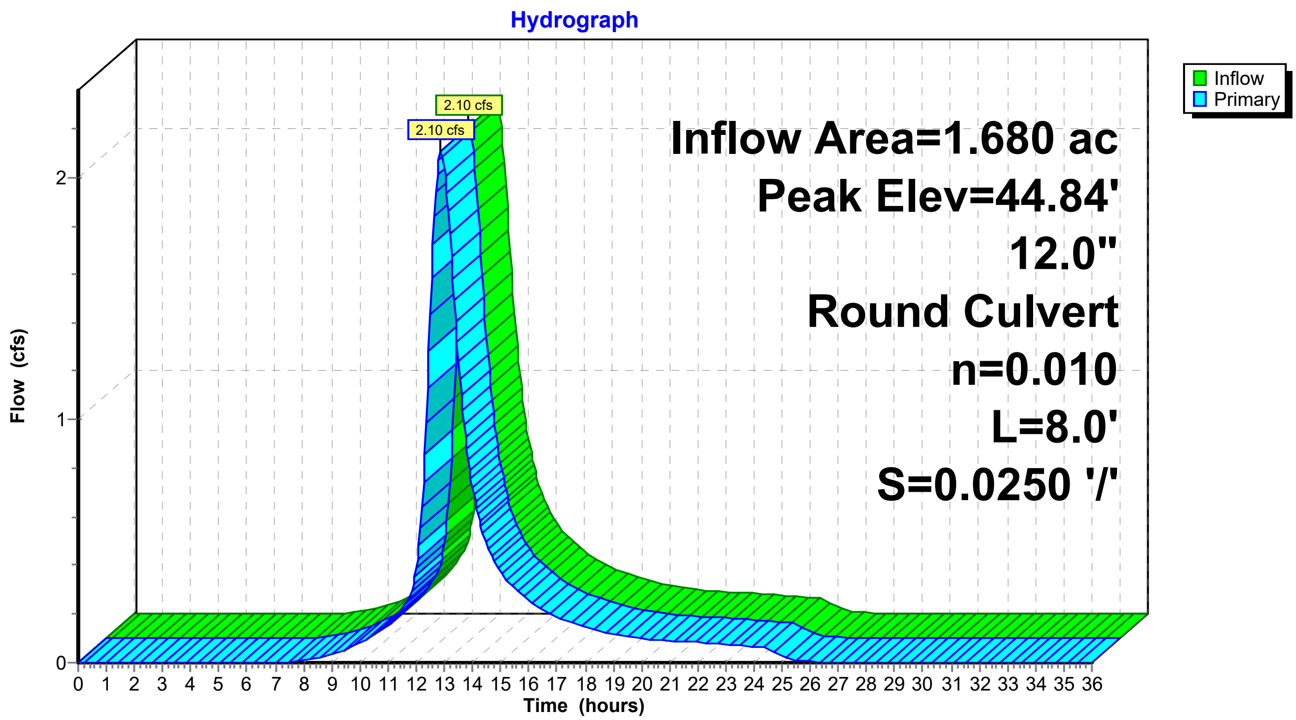
Inflow Area =	1.680 ac,	0.00% Impervious, Inflow Depth =	2.91"	for 10 yr event	
Inflow =	2.10 cfs @	12.88 hrs, Volume=	0.407 af		
Outflow =	2.10 cfs @	12.88 hrs, Volume=	0.407 af,	Atten= 0%,	Lag= 0.0 min
Primary =	2.10 cfs @	12.88 hrs, Volume=	0.407 af		

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 44.84' @ 12.88 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	44.00'	**12.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 44.00' / 43.80' S= 0.0250 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=2.10 cfs @ 12.88 hrs HW=44.84' TW=44.17' (Dynamic Tailwater)
1=Culvert (Barrel Controls 2.10 cfs @ 4.03 fps)

Pond BB 11 B: BB 11 B



Summary for Pond BB 11 S: BB 11 S

Inflow Area = 1.680 ac, 0.00% Impervious, Inflow Depth = 2.91" for 10 yr event
Inflow = 2.10 cfs @ 12.88 hrs, Volume= 0.407 af
Outflow = 1.55 cfs @ 13.32 hrs, Volume= 0.407 af, Atten= 26%, Lag= 26.3 min
Primary = 1.55 cfs @ 13.32 hrs, Volume= 0.407 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 44.49' @ 13.32 hrs Surf.Area= 0 sf Storage= 1,849 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 7.6 min (875.7 - 868.1)

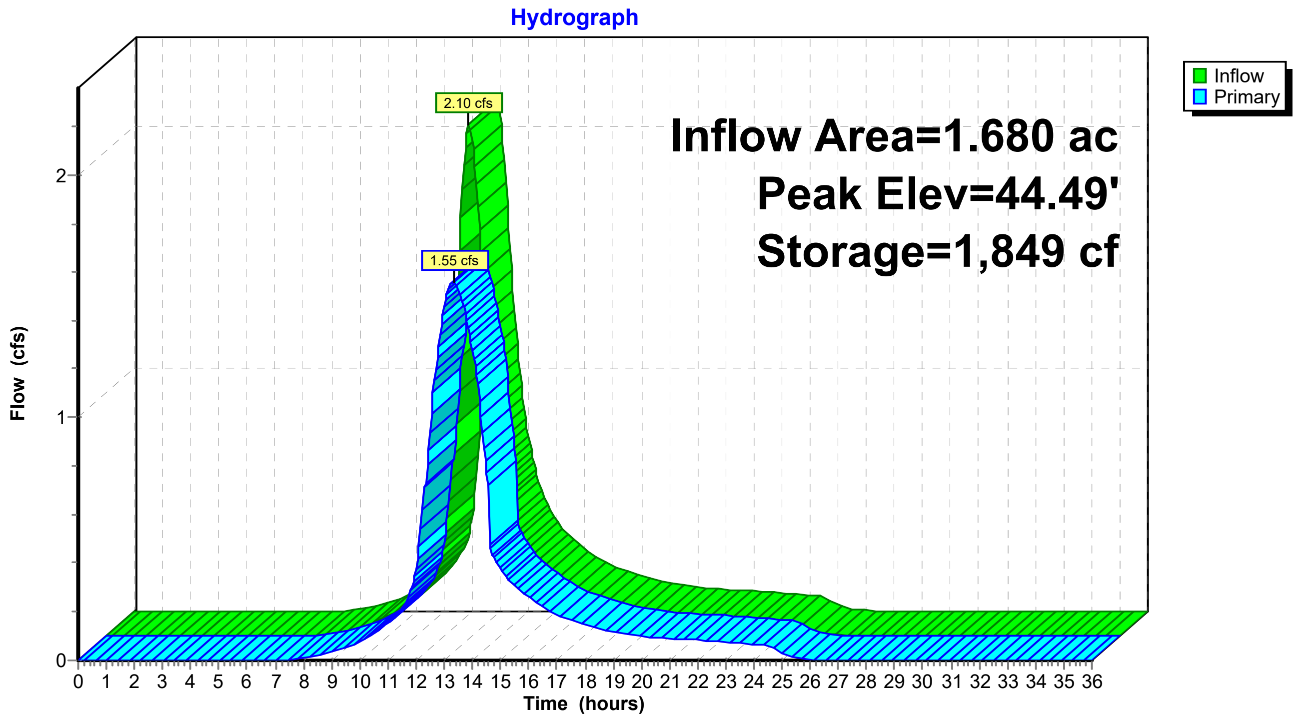
Volume	Invert	Avail.Storage	Storage Description
#1	42.97'	4,778 cf	**Custom Stage Data**Listed below

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
42.97	0	0
43.30	16	16
43.80	481	497
44.30	963	1,460
44.80	1,019	2,479
45.30	1,085	3,564
45.80	603	4,167
46.30	611	4,778

Device	Routing	Invert	Outlet Devices
#1	Primary	42.97'	**4.0" Round Culvert** L= 16.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 42.97' / 42.81' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.09 sf
#2	Primary	39.70'	**6.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 39.70' / 39.60' S= 0.0125 '/' Cc= 0.900 n= 0.010, Flow Area= 0.20 sf
#3	Primary	44.50'	**8.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 44.50' / 44.40' S= 0.0125 '/' Cc= 0.900 n= 0.010, Flow Area= 0.35 sf

Primary OutFlow Max=1.55 cfs @ 13.32 hrs HW=44.49' TW=43.19' (Dynamic Tailwater)
├─**1=Culvert** (Outlet Controls 0.48 cfs @ 5.47 fps)
├─**2=Culvert** (Inlet Controls 1.08 cfs @ 5.48 fps)
└─**3=Culvert** (Controls 0.00 cfs)

Pond BB 11 S: BB 11 S



Summary for Pond PR-4: PR-4

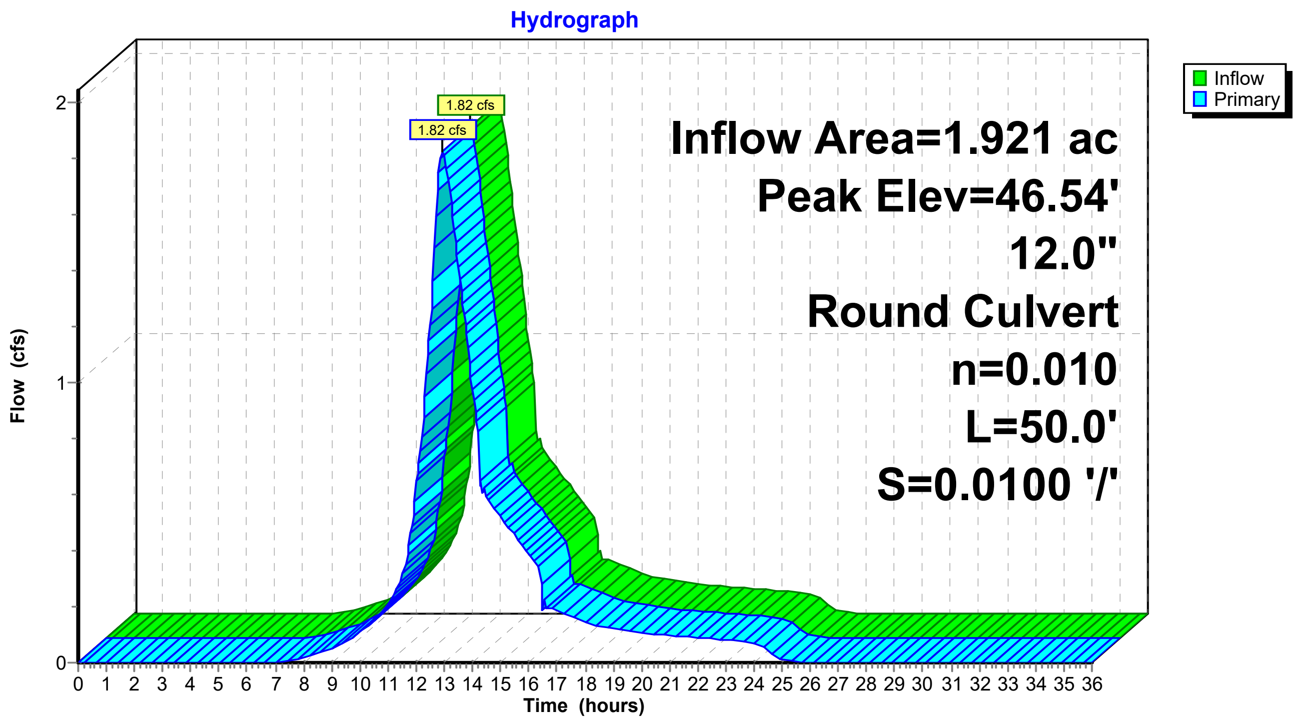
Inflow Area = 1.921 ac, 1.30% Impervious, Inflow Depth = 2.82" for 10 yr event
Inflow = 1.82 cfs @ 12.94 hrs, Volume= 0.451 af
Outflow = 1.82 cfs @ 12.94 hrs, Volume= 0.451 af, Atten= 0%, Lag= 0.0 min
Primary = 1.82 cfs @ 12.94 hrs, Volume= 0.451 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 46.54' @ 12.94 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	45.80'	**12.0" Round Culvert** L= 50.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 45.80' / 45.30' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=1.82 cfs @ 12.94 hrs HW=46.54' TW=0.00' (Dynamic Tailwater)
1=Culvert (Inlet Controls 1.82 cfs @ 2.93 fps)

Pond PR-4: PR-4



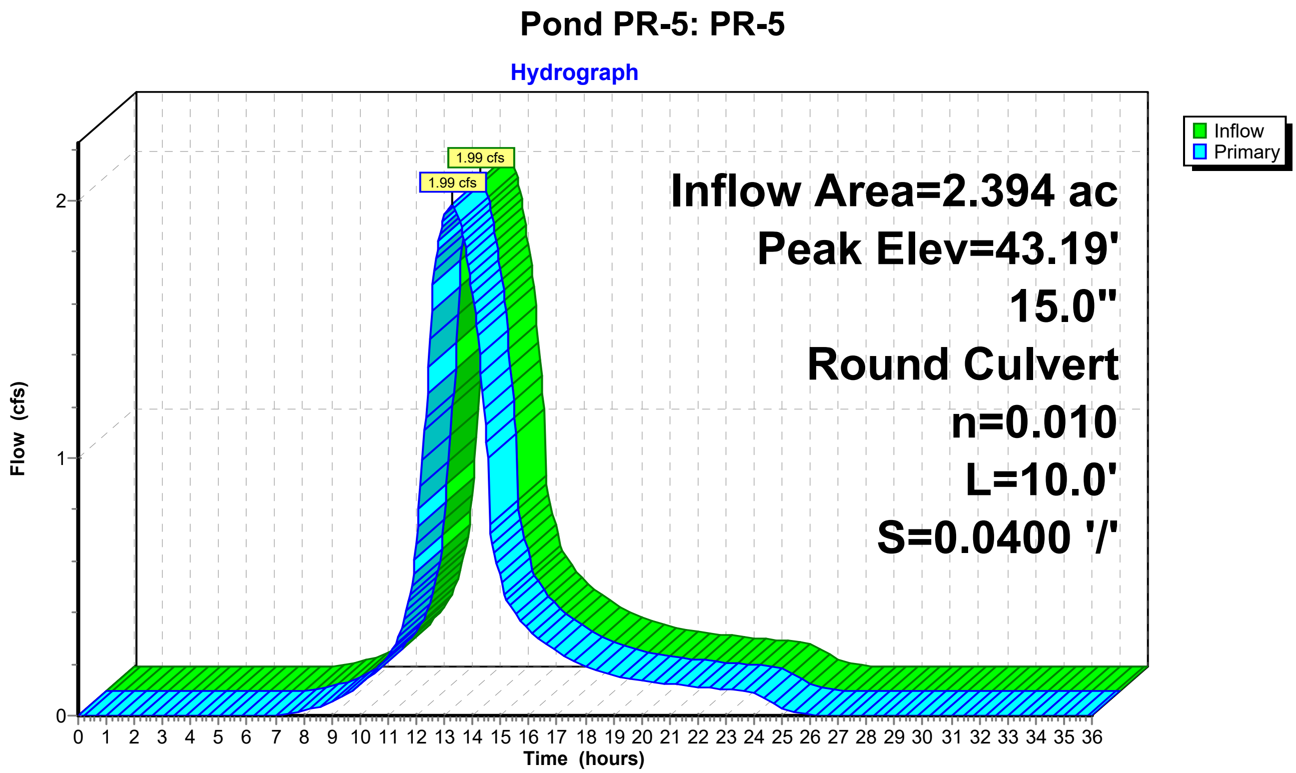
Summary for Pond PR-5: PR-5

Inflow Area =	2.394 ac,	0.58% Impervious,	Inflow Depth = 2.80"	for 10 yr event	
Inflow =	1.99 cfs @	13.26 hrs,	Volume=	0.559 af	
Outflow =	1.99 cfs @	13.26 hrs,	Volume=	0.559 af,	Atten= 0%, Lag= 0.0 min
Primary =	1.99 cfs @	13.26 hrs,	Volume=	0.559 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 43.19' @ 13.26 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	42.50'	**15.0" Round Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 42.50' / 42.10' S= 0.0400 '/' Cc= 0.900 n= 0.010, Flow Area= 1.23 sf

Primary OutFlow Max=1.99 cfs @ 13.26 hrs HW=43.19' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 1.99 cfs @ 2.84 fps)



Summary for Pond SB 01 B: SB 01 B

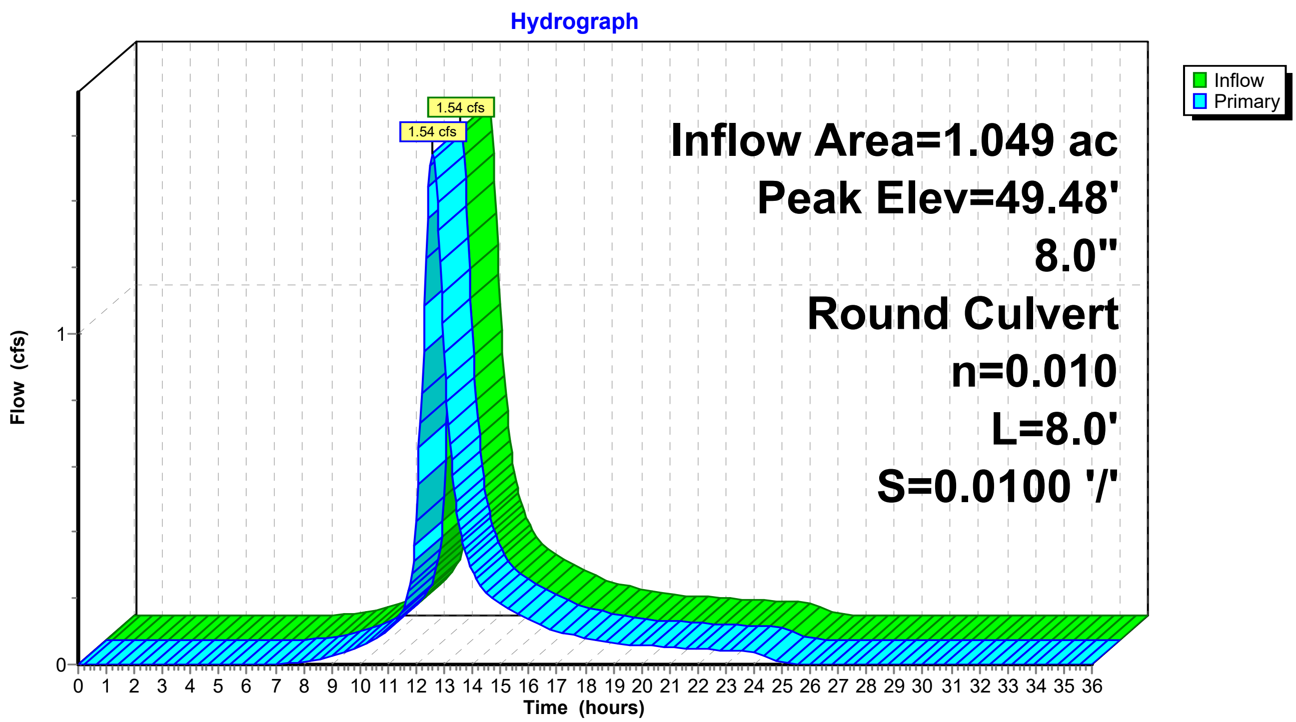
Inflow Area = 1.049 ac, 2.38% Impervious, Inflow Depth = 2.75" for 10 yr event
Inflow = 1.54 cfs @ 12.57 hrs, Volume= 0.240 af
Outflow = 1.54 cfs @ 12.57 hrs, Volume= 0.240 af, Atten= 0%, Lag= 0.0 min
Primary = 1.54 cfs @ 12.57 hrs, Volume= 0.240 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 49.48' @ 12.57 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	48.30'	**8.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 48.30' / 48.22' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.35 sf

Primary OutFlow Max=1.54 cfs @ 12.57 hrs HW=49.47' TW=47.58' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 1.54 cfs @ 4.41 fps)

Pond SB 01 B: SB 01 B



Summary for Pond SB 01 S: SB 01 S

Inflow Area = 1.049 ac, 2.38% Impervious, Inflow Depth = 2.75" for 10 yr event
Inflow = 1.54 cfs @ 12.57 hrs, Volume= 0.240 af
Outflow = 0.99 cfs @ 12.97 hrs, Volume= 0.240 af, Atten= 36%, Lag= 23.7 min
Primary = 0.99 cfs @ 12.97 hrs, Volume= 0.240 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 47.90' @ 12.98 hrs Surf.Area= 0 sf Storage= 1,424 cf

Plug-Flow detention time= 9.7 min calculated for 0.240 af (100% of inflow)
Center-of-Mass det. time= 9.7 min (857.1 - 847.3)

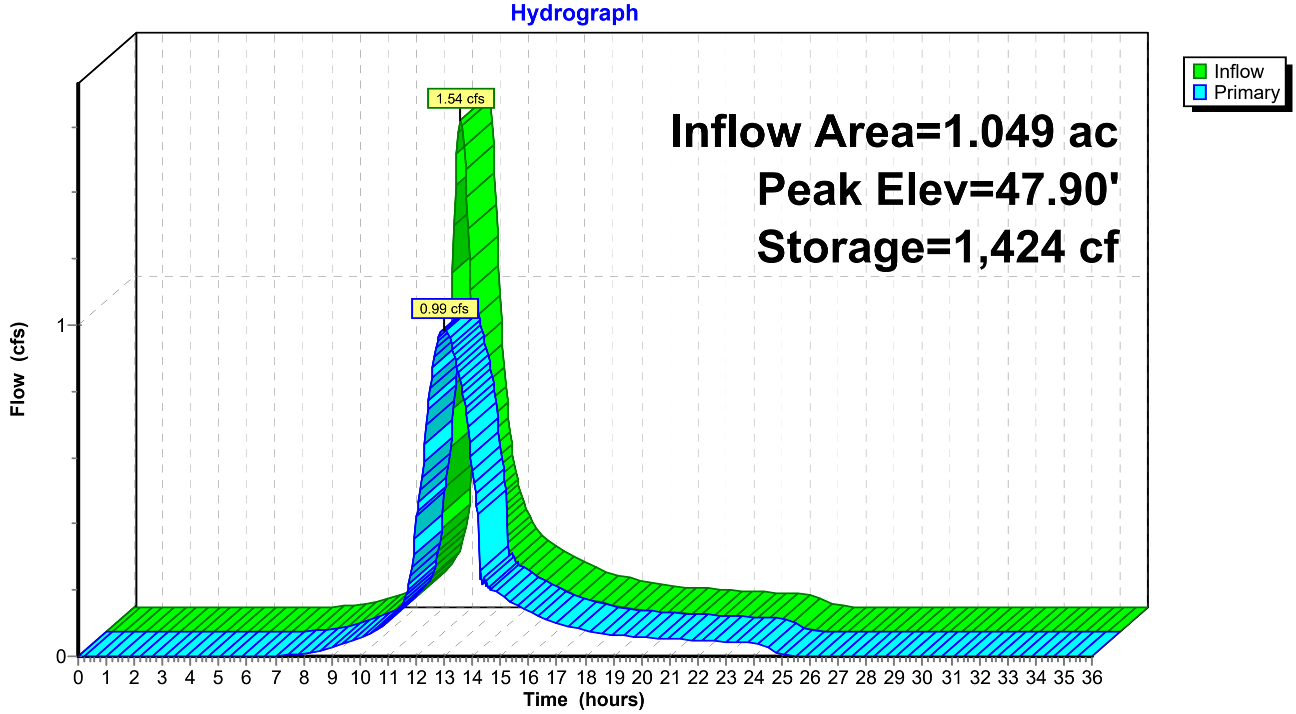
Volume	Invert	Avail.Storage	Storage Description
#1	46.30'	4,121 cf	**Custom Stage Data**Listed below

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
46.30	0	0
46.80	16	16
47.30	386	402
47.80	837	1,239
48.30	886	2,125
48.80	943	3,068
49.30	523	3,591
49.80	530	4,121

Device	Routing	Invert	Outlet Devices
#1	Primary	46.30'	**6.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 46.30' / 46.20' S= 0.0125 '/' Cc= 0.900 n= 0.010, Flow Area= 0.20 sf
#2	Primary	48.30'	**8.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 48.30' / 48.22' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.35 sf

Primary OutFlow Max=0.99 cfs @ 12.97 hrs HW=47.90' TW=46.82' (Dynamic Tailwater)
1=Culvert (Inlet Controls 0.99 cfs @ 5.02 fps)
2=Culvert (Controls 0.00 cfs)

Pond SB 01 S: SB 01 S



Summary for Pond SB 03 B: SB 03B

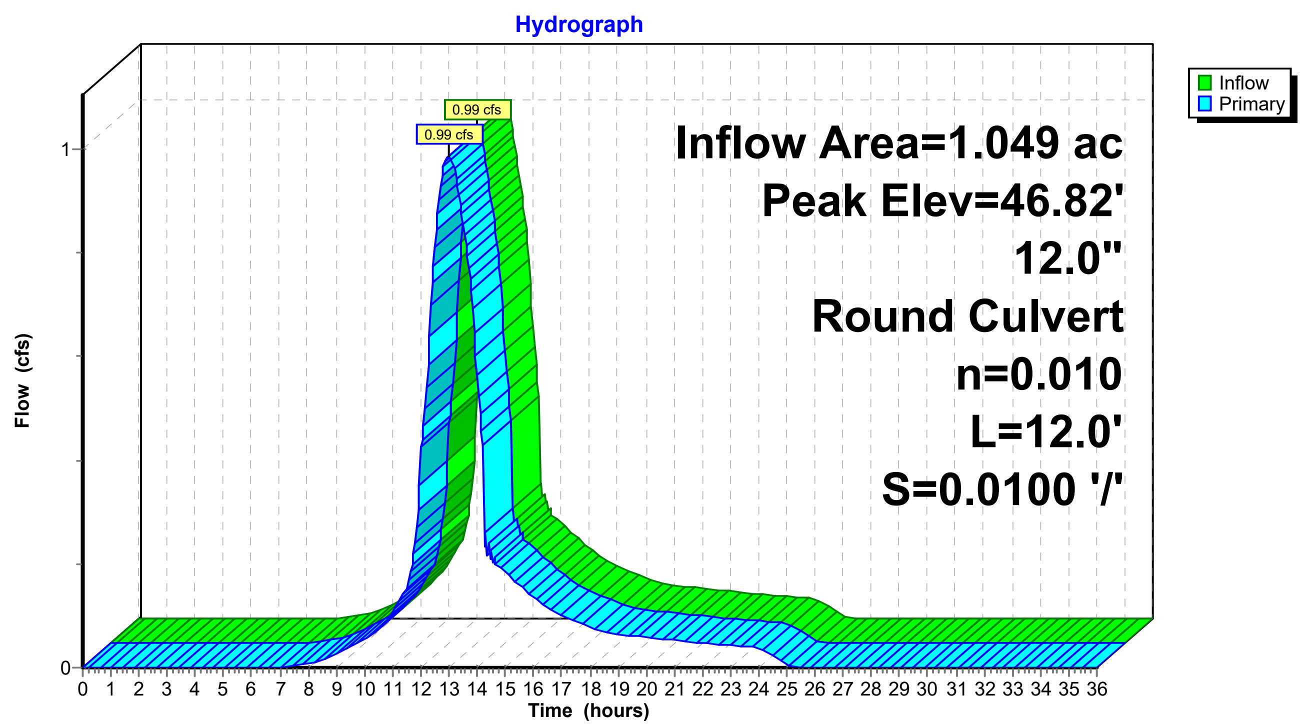
Inflow Area =	1.049 ac,	2.38% Impervious, Inflow Depth = 2.75"	for 10 yr event	
Inflow =	0.99 cfs @	12.97 hrs, Volume=	0.240 af	
Outflow =	0.99 cfs @	12.97 hrs, Volume=	0.240 af,	Atten= 0%, Lag= 0.0 min
Primary =	0.99 cfs @	12.97 hrs, Volume=	0.240 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 46.82' @ 12.97 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	46.25'	**12.0" Round Culvert** L= 12.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 46.25' / 46.13' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=0.99 cfs @ 12.97 hrs HW=46.82' TW=46.54' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 0.99 cfs @ 3.10 fps)

Pond SB 03 B: SB 03B



Summary for Pond SB 11 B: SB 11 B

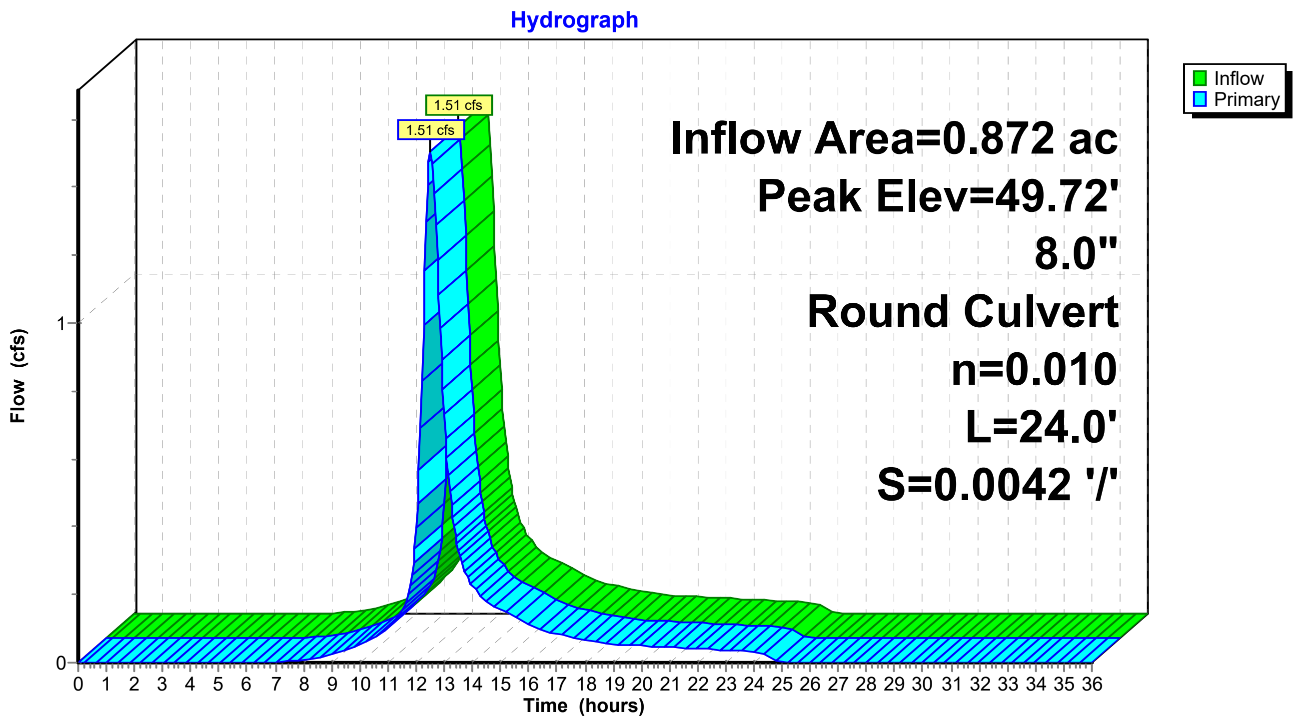
Inflow Area = 0.872 ac, 0.00% Impervious, Inflow Depth = 2.91" for 10 yr event
Inflow = 1.51 cfs @ 12.51 hrs, Volume= 0.211 af
Outflow = 1.51 cfs @ 12.51 hrs, Volume= 0.211 af, Atten= 0%, Lag= 0.0 min
Primary = 1.51 cfs @ 12.51 hrs, Volume= 0.211 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 49.72' @ 12.51 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	48.50'	**8.0" Round Culvert** L= 24.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 48.50' / 48.40' S= 0.0042 '/' Cc= 0.900 n= 0.010, Flow Area= 0.35 sf

Primary OutFlow Max=1.51 cfs @ 12.51 hrs HW=49.72' TW=48.04' (Dynamic Tailwater)
1=Culvert (Barrel Controls 1.51 cfs @ 4.31 fps)

Pond SB 11 B: SB 11 B



Summary for Pond SB 11 S: SB 11 S

Inflow Area = 0.872 ac, 0.00% Impervious, Inflow Depth = 2.91" for 10 yr event
Inflow = 1.51 cfs @ 12.51 hrs, Volume= 0.211 af
Outflow = 0.84 cfs @ 12.93 hrs, Volume= 0.211 af, Atten= 44%, Lag= 25.2 min
Primary = 0.84 cfs @ 12.93 hrs, Volume= 0.211 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 48.48' @ 12.93 hrs Surf.Area= 0 sf Storage= 2,214 cf

Plug-Flow detention time= 31.9 min calculated for 0.211 af (100% of inflow)
Center-of-Mass det. time= 31.5 min (872.3 - 840.8)

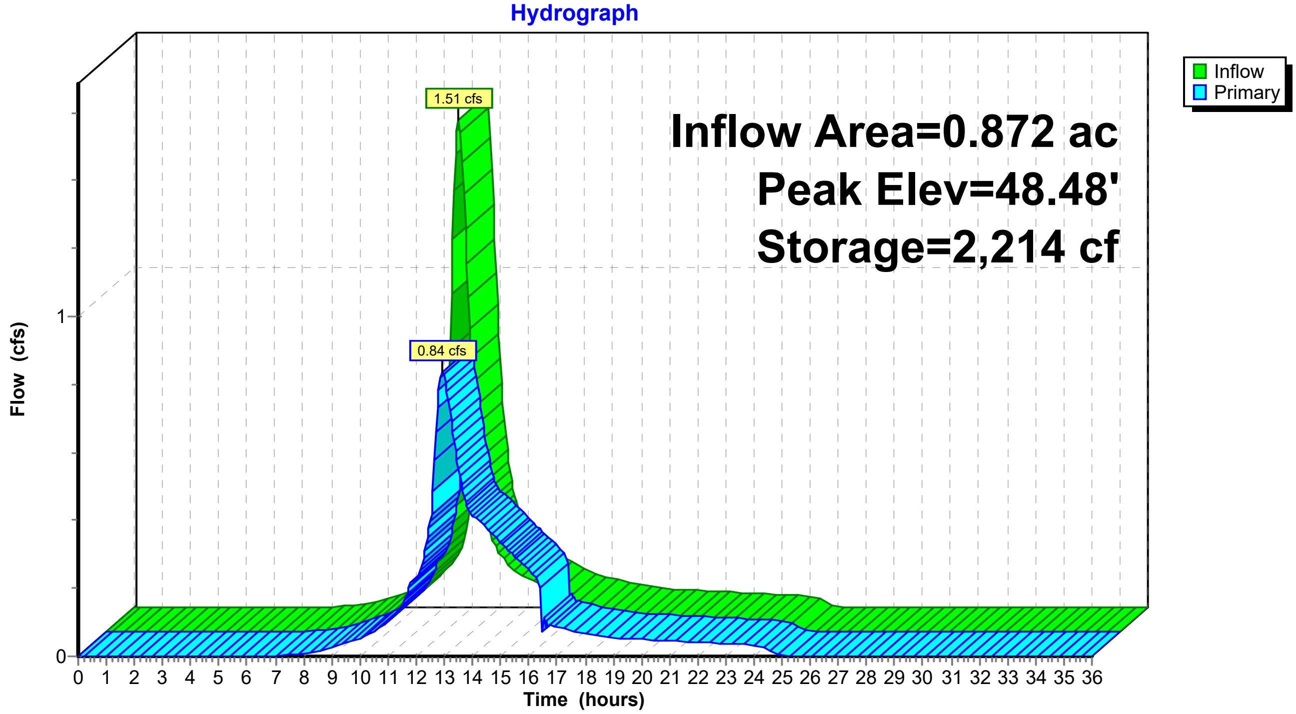
Volume	Invert	Avail.Storage	Storage Description
#1	46.80'	3,953 cf	**Custom Stage Data** Listed below

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
46.80	0	0
47.30	16	16
47.80	888	904
48.30	944	1,848
48.80	1,001	2,849
49.30	544	3,393
49.80	560	3,953

Device	Routing	Invert	Outlet Devices
#1	Primary	46.80'	**4.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 46.80' / 46.72' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.09 sf
#2	Primary	48.10'	**8.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 48.10' / 48.00' S= 0.0125 '/' Cc= 0.900 n= 0.010, Flow Area= 0.35 sf

Primary OutFlow Max=0.84 cfs @ 12.93 hrs HW=48.48' TW=47.31' (Dynamic Tailwater)
1=Culvert (Inlet Controls 0.46 cfs @ 5.22 fps)
2=Culvert (Barrel Controls 0.38 cfs @ 2.65 fps)

Pond SB 11 S: SB 11 S



Summary for Pond SB 12 B: SB 12 B

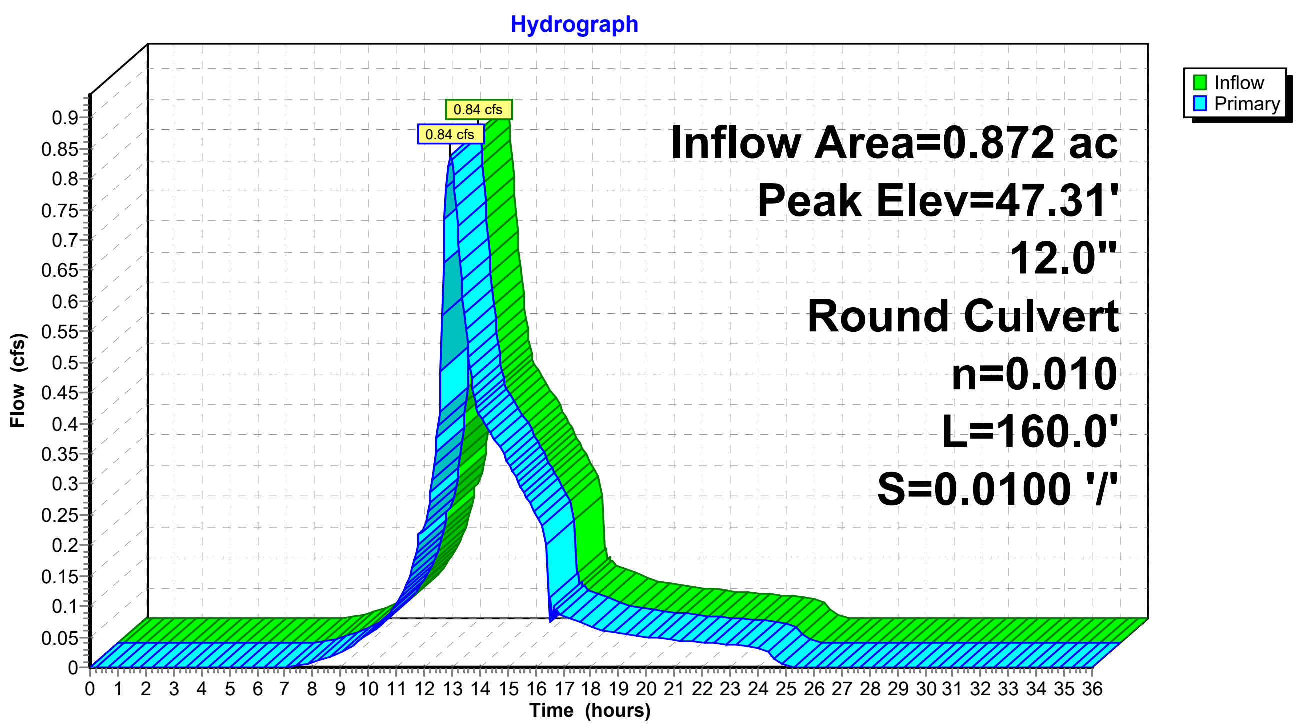
Inflow Area =	0.872 ac,	0.00% Impervious, Inflow Depth = 2.91"	for 10 yr event		
Inflow =	0.84 cfs @	12.93 hrs, Volume=	0.211 af		
Outflow =	0.84 cfs @	12.93 hrs, Volume=	0.211 af,	Atten= 0%,	Lag= 0.0 min
Primary =	0.84 cfs @	12.93 hrs, Volume=	0.211 af		

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 47.31' @ 12.94 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	46.80'	**12.0" Round Culvert** L= 160.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 46.80' / 45.20' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=0.83 cfs @ 12.93 hrs HW=47.31' TW=46.54' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 0.83 cfs @ 3.04 fps)

Pond SB 12 B: SB 12 B

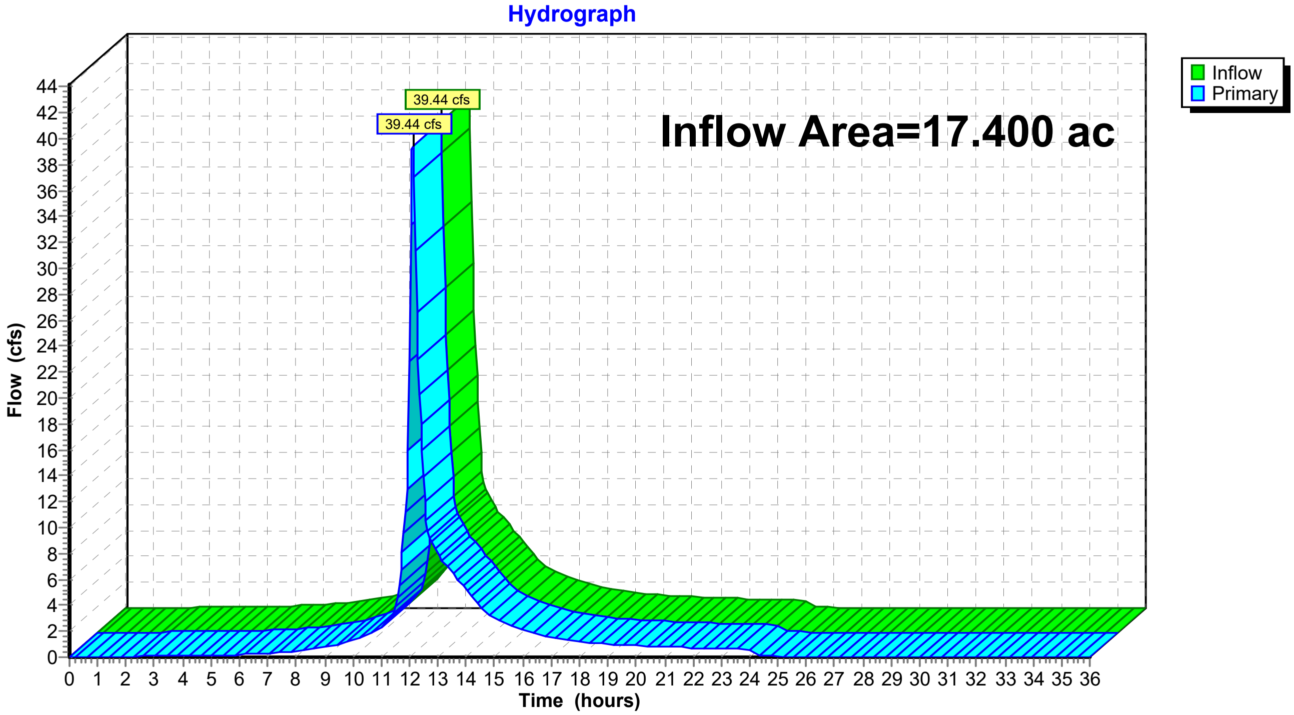


Summary for Link POA: POA

Inflow Area = 17.400 ac, 49.60% Impervious, Inflow Depth > 2.85" for 10 yr event
Inflow = 39.44 cfs @ 12.11 hrs, Volume= 4.138 af
Primary = 39.44 cfs @ 12.11 hrs, Volume= 4.138 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Link POA: POA



Summary for Subcatchment PR-1: PR-1

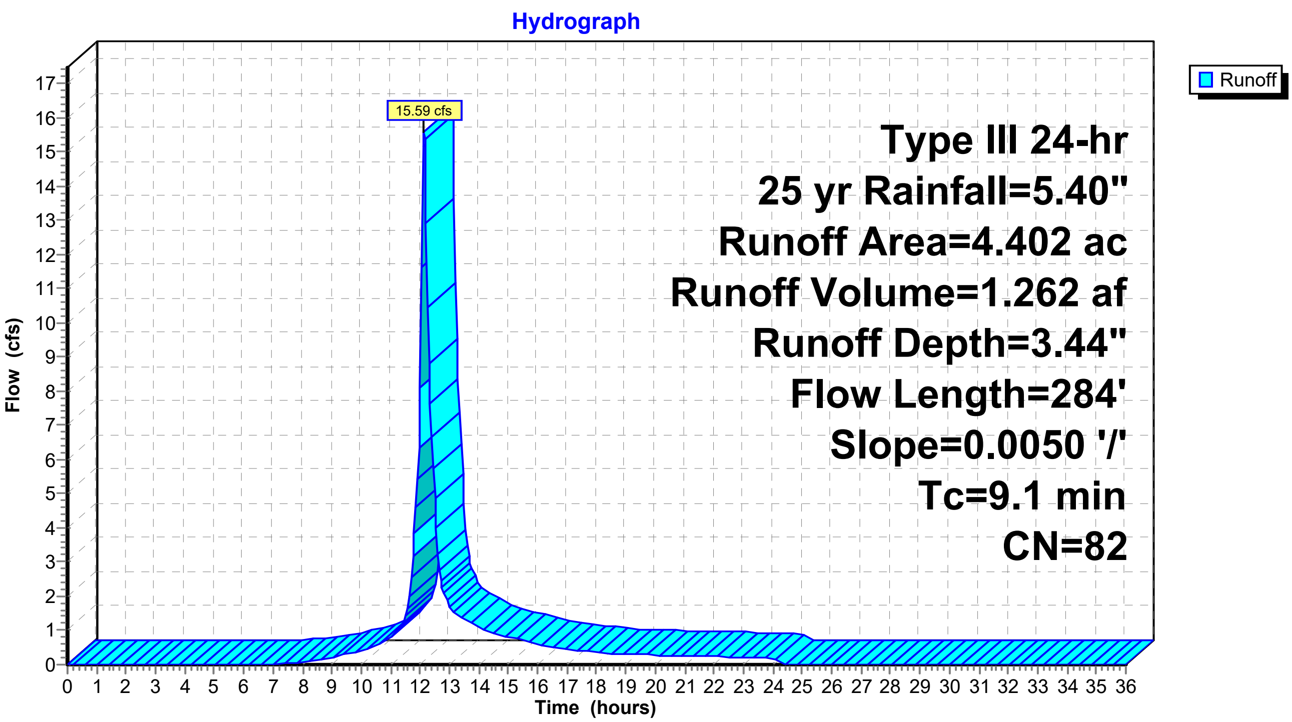
Runoff = 15.59 cfs @ 12.13 hrs, Volume= 1.262 af, Depth= 3.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.40"

Area (ac)	CN	Description
1.892	61	>75% Grass cover, Good, HSG B
2.510	98	Paved parking, HSG B
4.402	82	Weighted Average
1.892		42.98% Pervious Area
2.510		57.02% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	50	0.0050	0.69		**Sheet Flow, A-B** Smooth surfaces n= 0.011 P2= 3.20"
7.9	234	0.0050	0.49		**Shallow Concentrated Flow, B-C** Short Grass Pasture Kv= 7.0 fps
9.1	284	Total			

Subcatchment PR-1: PR-1



Summary for Subcatchment PR-1A: PR-1A

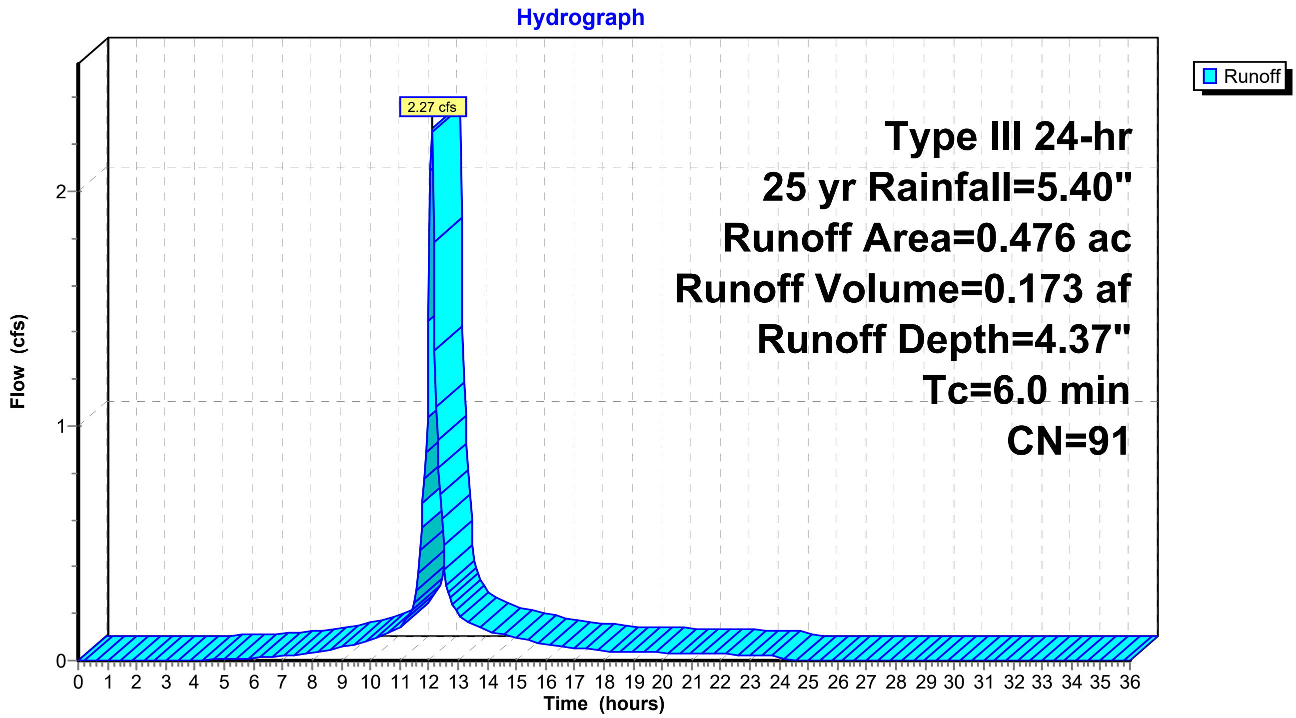
Runoff = 2.27 cfs @ 12.09 hrs, Volume= 0.173 af, Depth= 4.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.40"

Area (ac)	CN	Description
0.090	61	>75% Grass cover, Good, HSG B
0.386	98	Paved parking, HSG B
0.476	91	Weighted Average
0.090		18.91% Pervious Area
0.386		81.09% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-1A: PR-1A



Summary for Subcatchment PR-1B: PR-1B

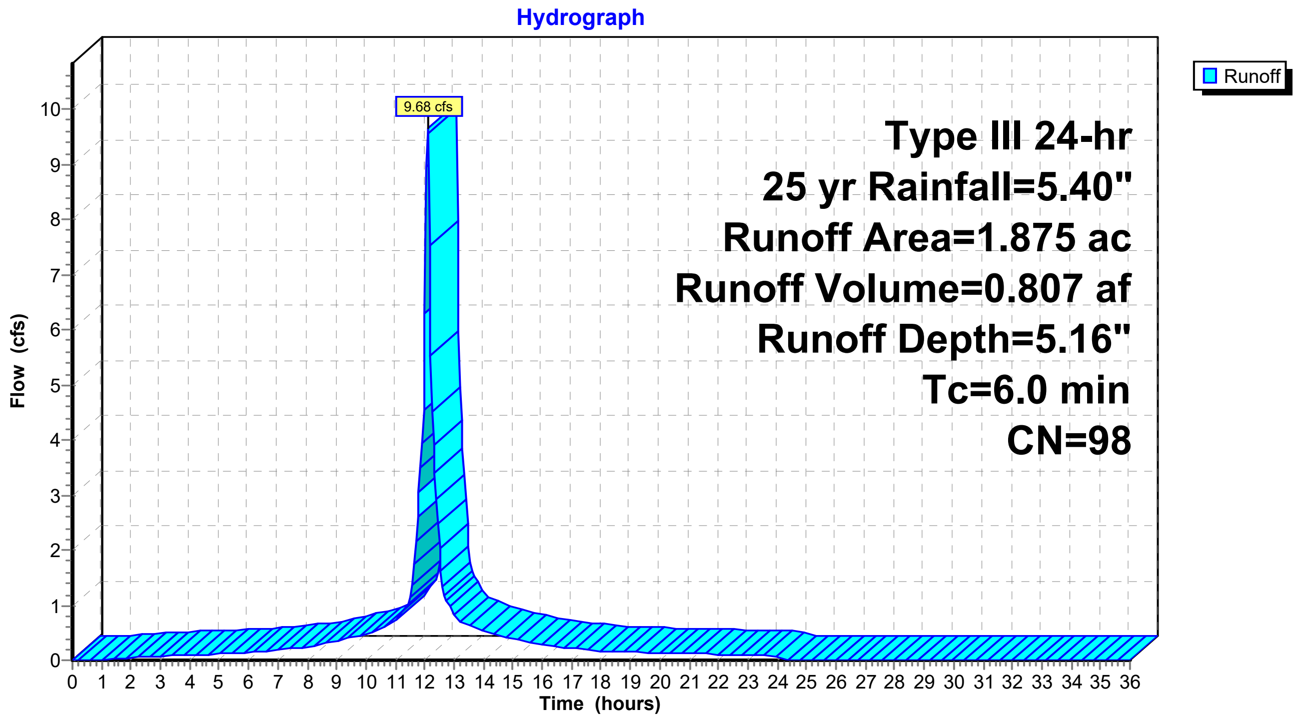
Runoff = 9.68 cfs @ 12.09 hrs, Volume= 0.807 af, Depth= 5.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.40"

Area (ac)	CN	Description
1.875	98	Roofs, HSG B
1.875		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-1B: PR-1B



Summary for Subcatchment PR-1C: PR-1C

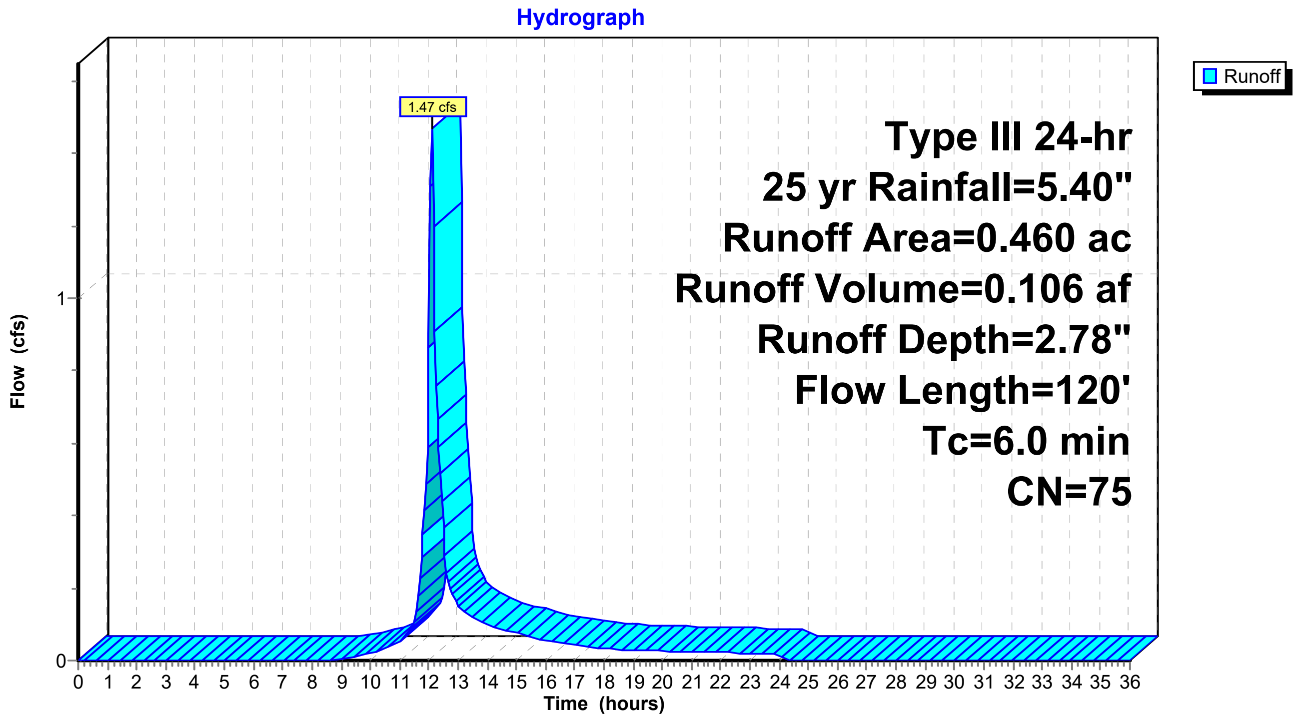
Runoff = 1.47 cfs @ 12.09 hrs, Volume= 0.106 af, Depth= 2.78"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.40"

Area (ac)	CN	Description
0.020	55	Woods, Good, HSG B
0.260	61	>75% Grass cover, Good, HSG B
0.180	98	Paved parking, HSG B
0.460	75	Weighted Average
0.280		60.87% Pervious Area
0.180		39.13% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	20	0.0700	0.09		**Sheet Flow, 20' SF** Woods: Light underbrush n= 0.400 P2= 3.20"
1.9	40	0.5000	0.35		**Sheet Flow, 30' SF** Grass: Dense n= 0.240 P2= 3.20"
0.1	12	0.0100	1.61		**Shallow Concentrated Flow, 12' SCF** Unpaved Kv= 16.1 fps
0.2	48	0.0400	4.06		**Shallow Concentrated Flow, 48' SCF** Paved Kv= 20.3 fps
5.8	120	Total, Increased to minimum Tc = 6.0 min			

Subcatchment PR-1C: PR-1C



Summary for Subcatchment PR-1D: PR-1D

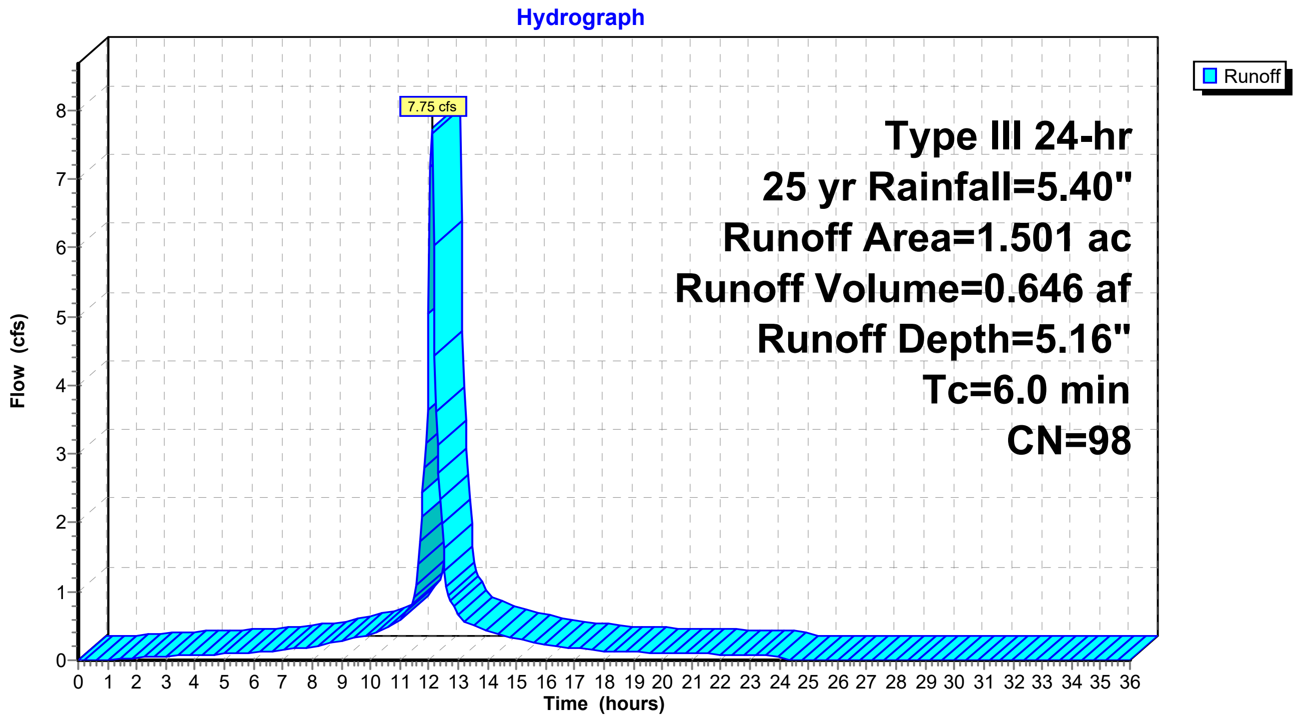
Runoff = 7.75 cfs @ 12.09 hrs, Volume= 0.646 af, Depth= 5.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.40"

Area (ac)	CN	Description
1.501	98	Roofs, HSG B
1.501		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-1D: PR-1D



Summary for Subcatchment PR-1E: PR-1E

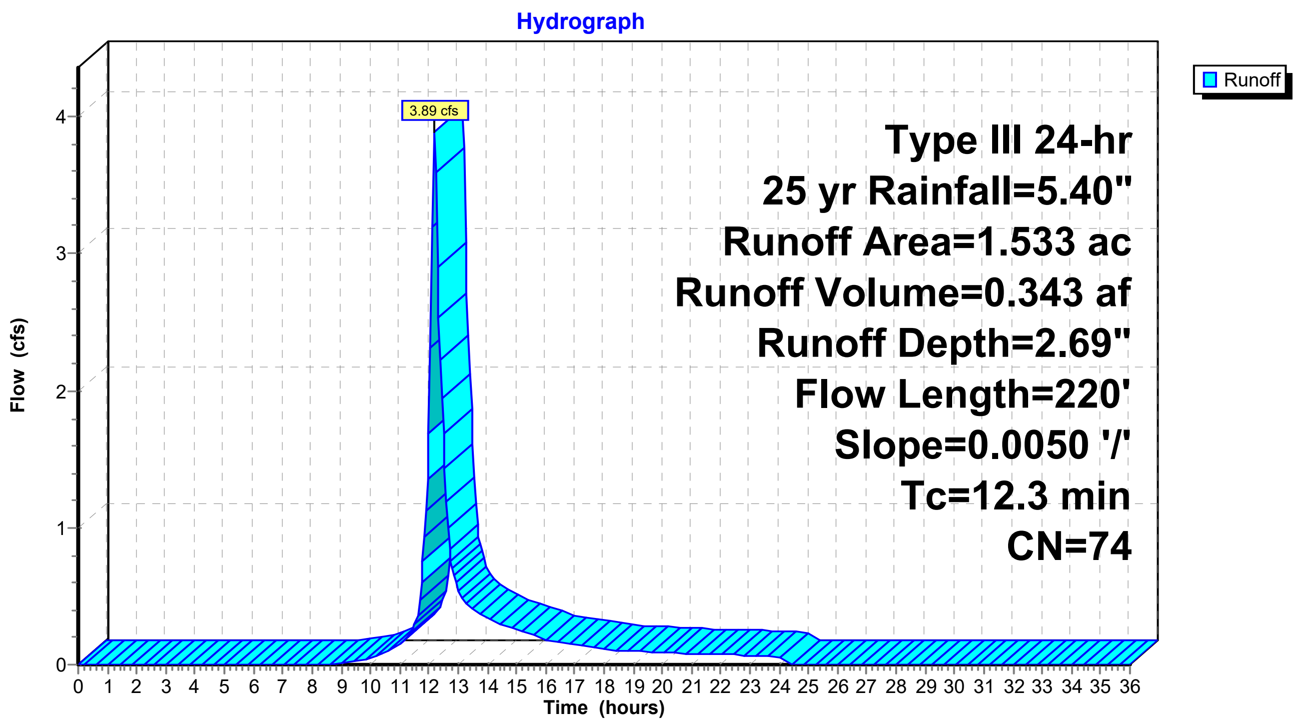
Runoff = 3.89 cfs @ 12.17 hrs, Volume= 0.343 af, Depth= 2.69"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.40"

Area (ac)	CN	Description
1.000	61	>75% Grass cover, Good, HSG B
0.533	98	Paved parking, HSG B
1.533	74	Weighted Average
1.000		65.23% Pervious Area
0.533		34.77% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.8	50	0.0050	0.09		**Sheet Flow, 50' SF** Grass: Short n= 0.150 P2= 3.20"
2.5	170	0.0050	1.14		**Shallow Concentrated Flow, 170' SCF** Unpaved Kv= 16.1 fps
12.3	220	Total			

Subcatchment PR-1E: PR-1E



Summary for Subcatchment PR-2: PR-2

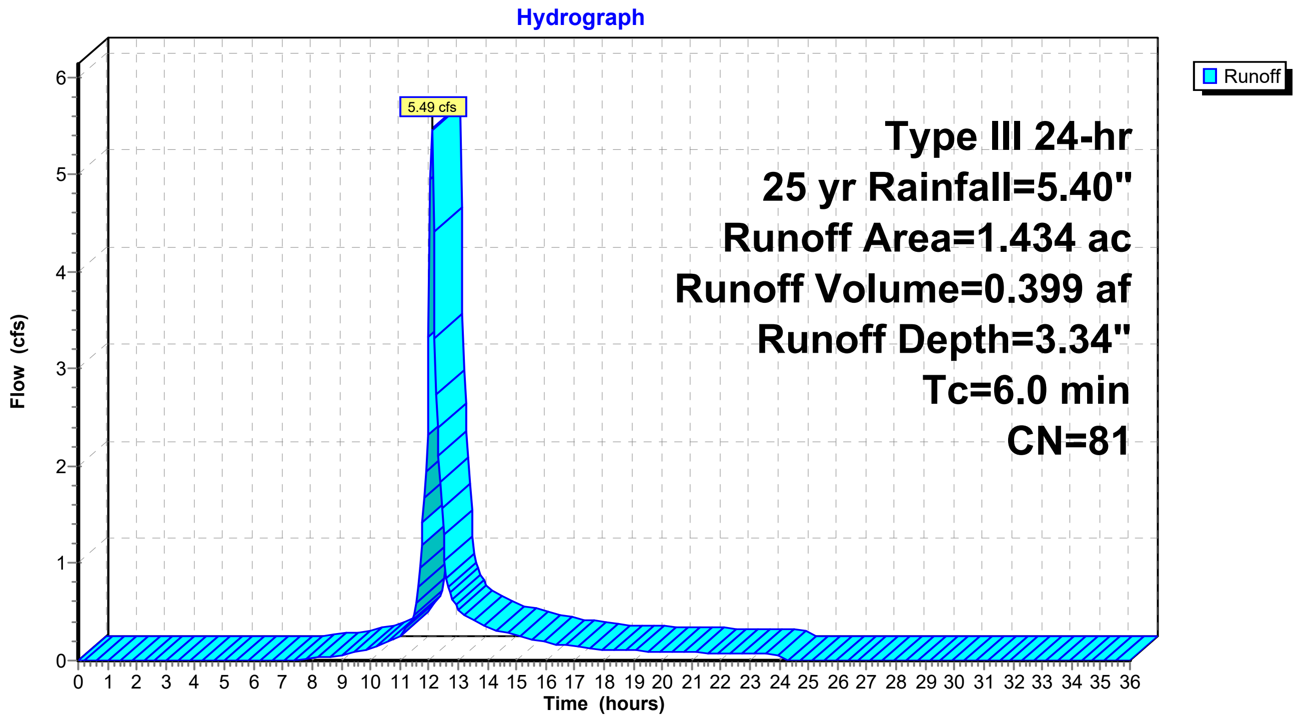
Runoff = 5.49 cfs @ 12.09 hrs, Volume= 0.399 af, Depth= 3.34"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.40"

Area (ac)	CN	Description
0.672	61	>75% Grass cover, Good, HSG B
0.762	98	Paved parking, HSG B
1.434	81	Weighted Average
0.672		46.86% Pervious Area
0.762		53.14% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-2: PR-2



Summary for Subcatchment PR-2A: PR-2B

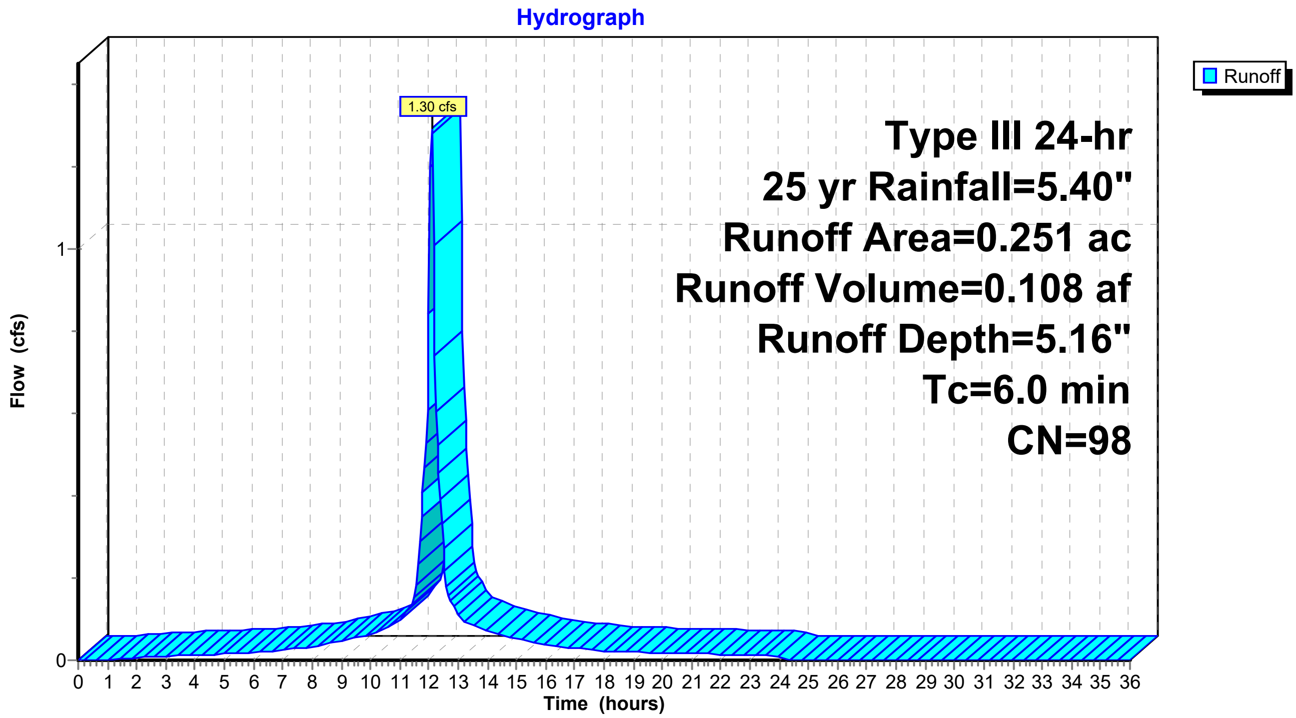
Runoff = 1.30 cfs @ 12.09 hrs, Volume= 0.108 af, Depth= 5.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.40"

Area (ac)	CN	Description
0.251	98	Roofs, HSG B
0.251		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-2A: PR-2B



Summary for Subcatchment PR-3A: PR-3A

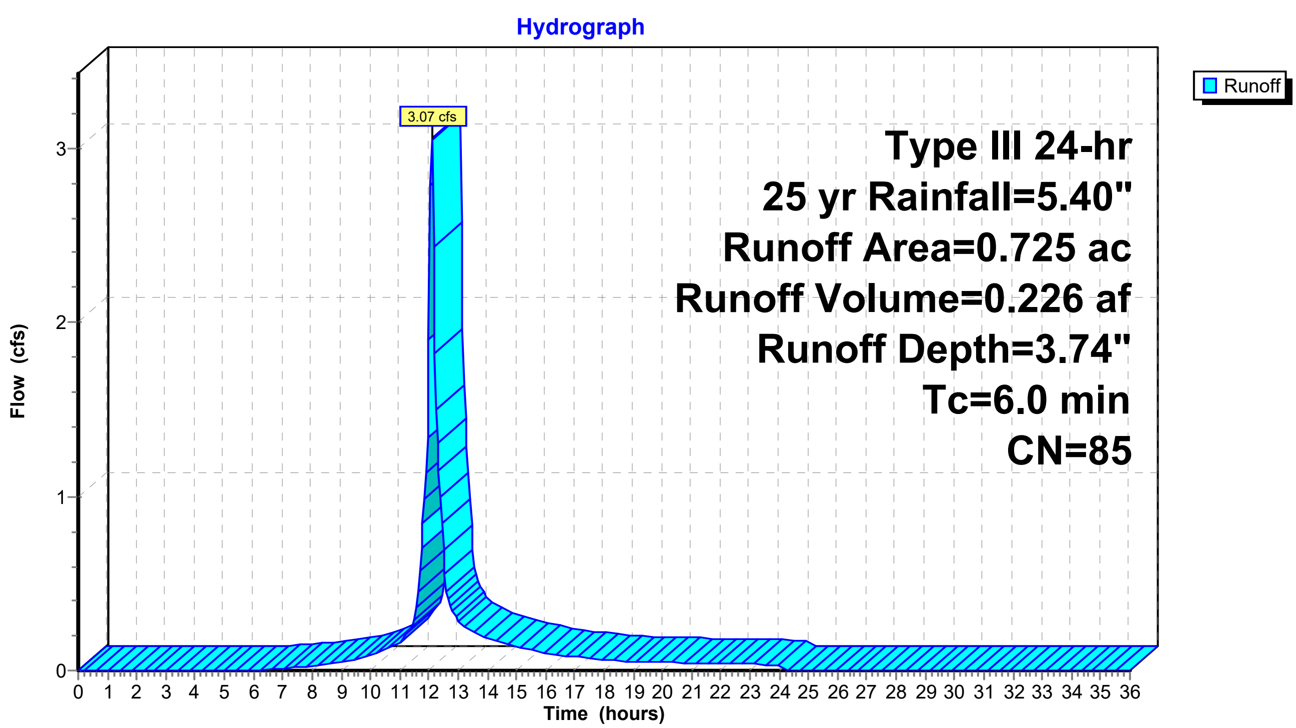
Runoff = 3.07 cfs @ 12.09 hrs, Volume= 0.226 af, Depth= 3.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.40"

Area (ac)	CN	Description
0.249	61	>75% Grass cover, Good, HSG B
0.476	98	Paved parking, HSG B
0.725	85	Weighted Average
0.249		34.34% Pervious Area
0.476		65.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-3A: PR-3A



Summary for Subcatchment PR-3B: PR-3B

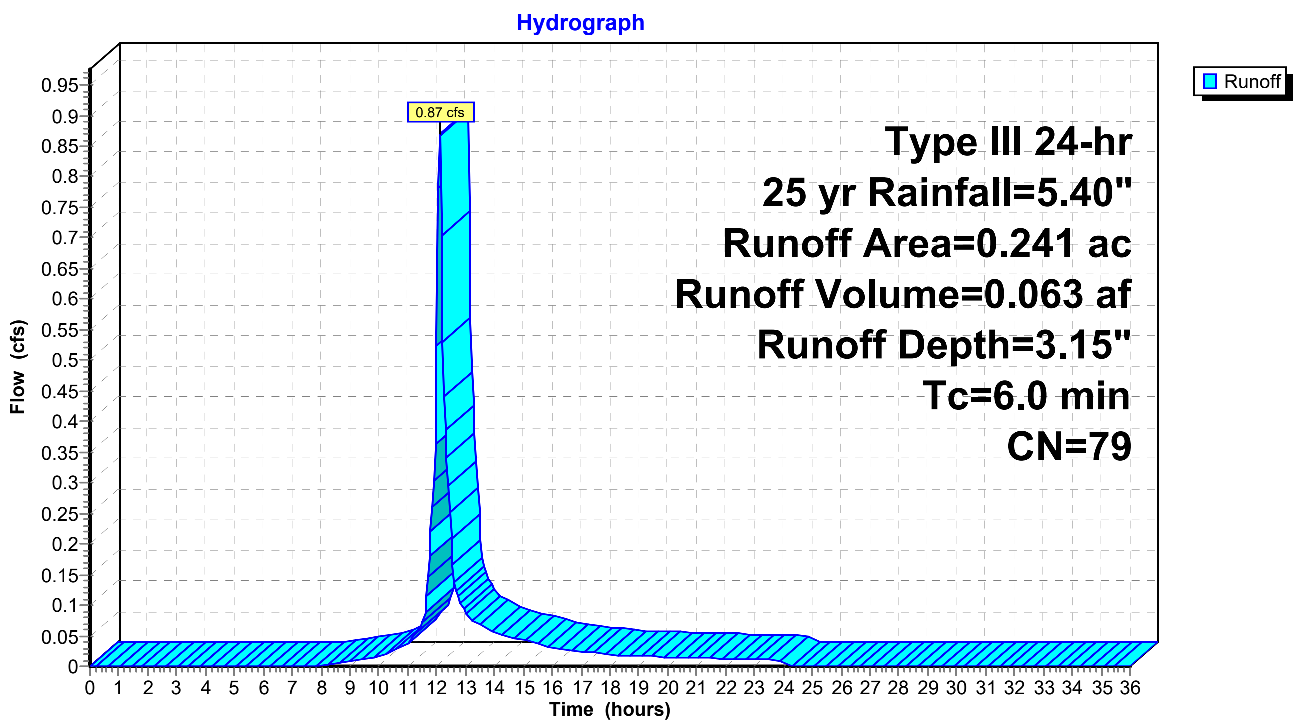
Runoff = 0.87 cfs @ 12.09 hrs, Volume= 0.063 af, Depth= 3.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.40"

Area (ac)	CN	Description
0.124	61	>75% Grass cover, Good, HSG B
0.117	98	Paved parking, HSG B
0.241	79	Weighted Average
0.124		51.45% Pervious Area
0.117		48.55% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-3B: PR-3B



Summary for Subcatchment PR-3C: PR-3C

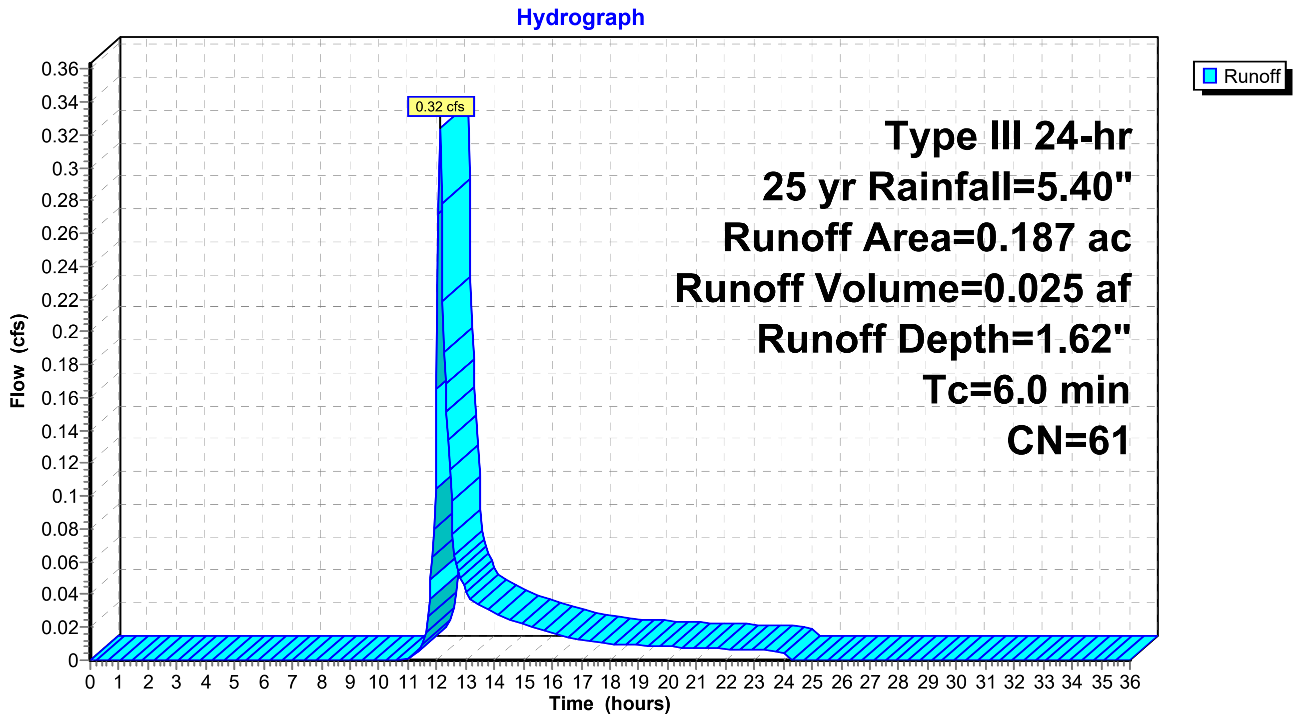
Runoff = 0.32 cfs @ 12.10 hrs, Volume= 0.025 af, Depth= 1.62"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.40"

Area (ac)	CN	Description
0.187	61	>75% Grass cover, Good, HSG B
0.187		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-3C: PR-3C



Summary for Subcatchment PR-4A: PR-5A

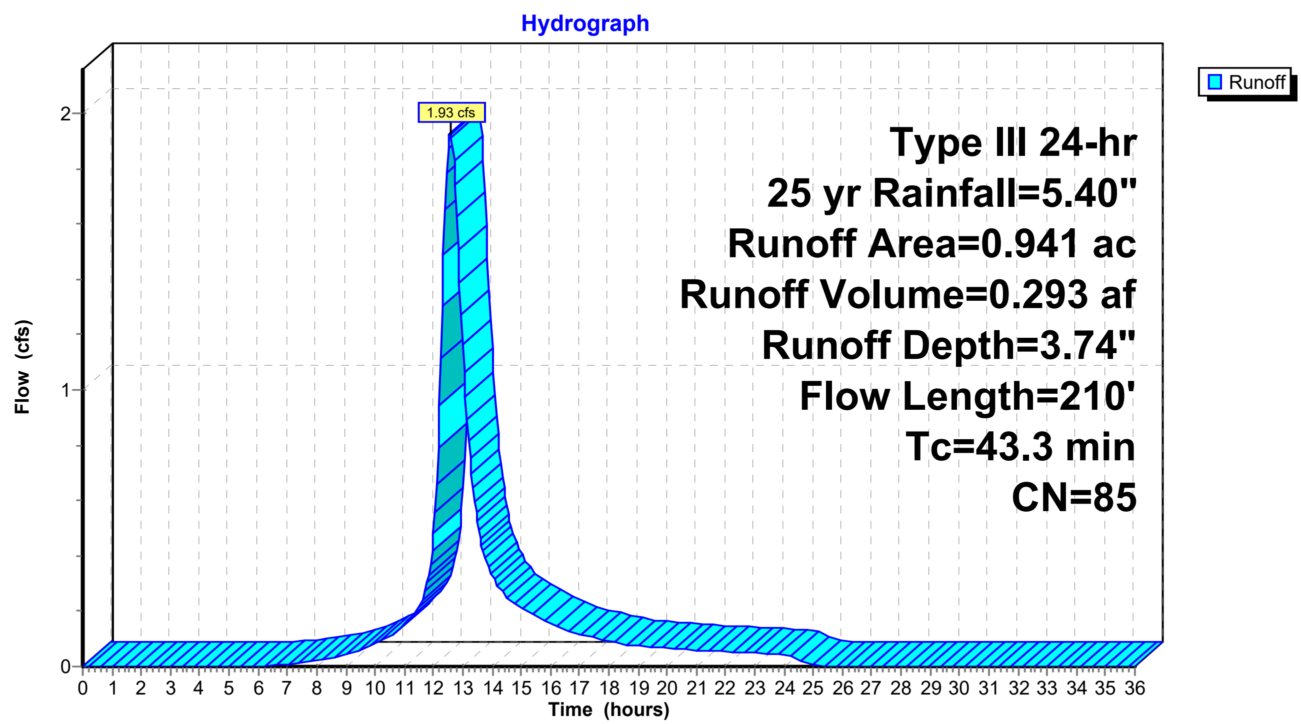
Runoff = 1.93 cfs @ 12.58 hrs, Volume= 0.293 af, Depth= 3.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.40"

	Area (ac)	CN	Description
*	0.941	85	SYNTHETIC TURF- PAD- LINER
	0.941		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
39.6	110	0.0055	0.05		**Sheet Flow, Through Turf Section** Grass: Bermuda n= 0.410 P2= 3.20"
3.7	100	0.0001	0.45	0.16	**Pipe Channel, TRENCH DRAIN LEVEL** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010
43.3	210	Total			

Subcatchment PR-4A: PR-5A



Summary for Subcatchment PR-4B: SB 11 A

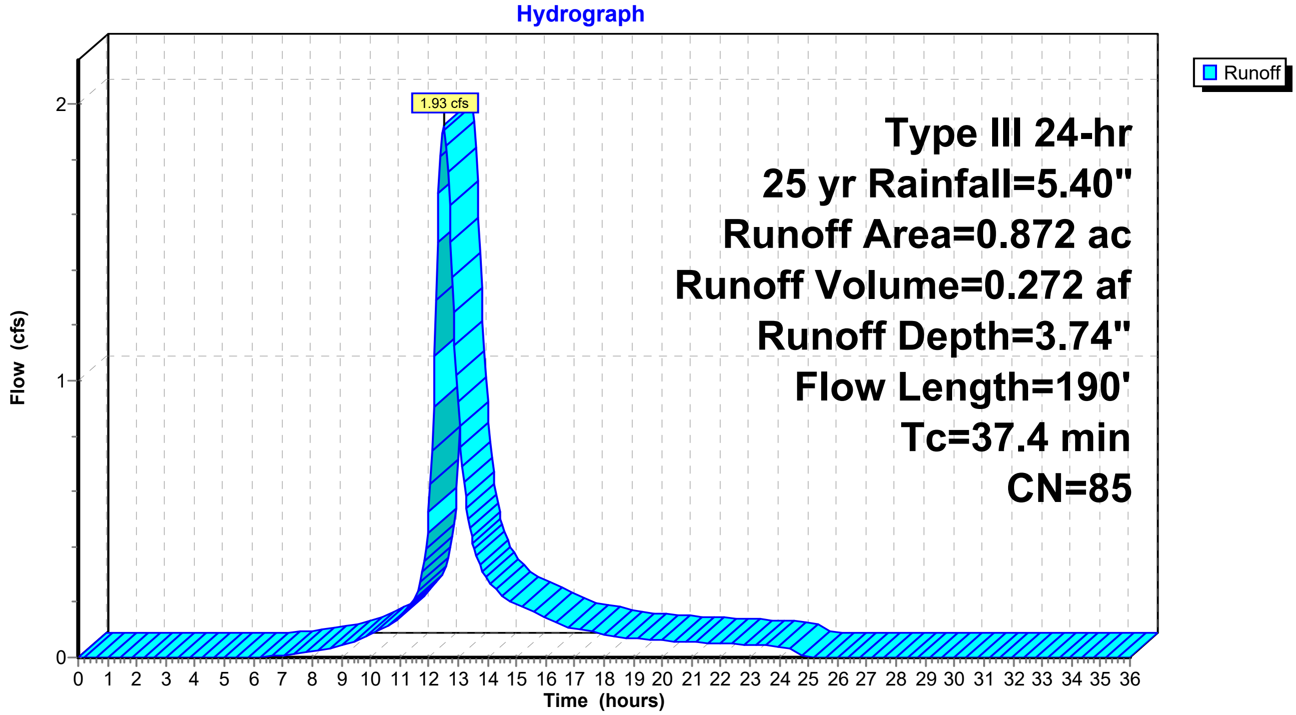
Runoff = 1.93 cfs @ 12.51 hrs, Volume= 0.272 af, Depth= 3.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.40"

	Area (ac)	CN	Description
*	0.872	85	SYNTHETIC TURF- PAD- LINER
	0.872		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
33.7	90	0.0055	0.04		**Sheet Flow, Through Turf Section** Grass: Bermuda n= 0.410 P2= 3.20"
3.7	100	0.0001	0.45	0.16	**Pipe Channel, TRENCH DRAIN LEVEL** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010
37.4	190	Total			

Subcatchment PR-4B: SB 11 A



Summary for Subcatchment PR-4C: SB 00 DPW SLOPE

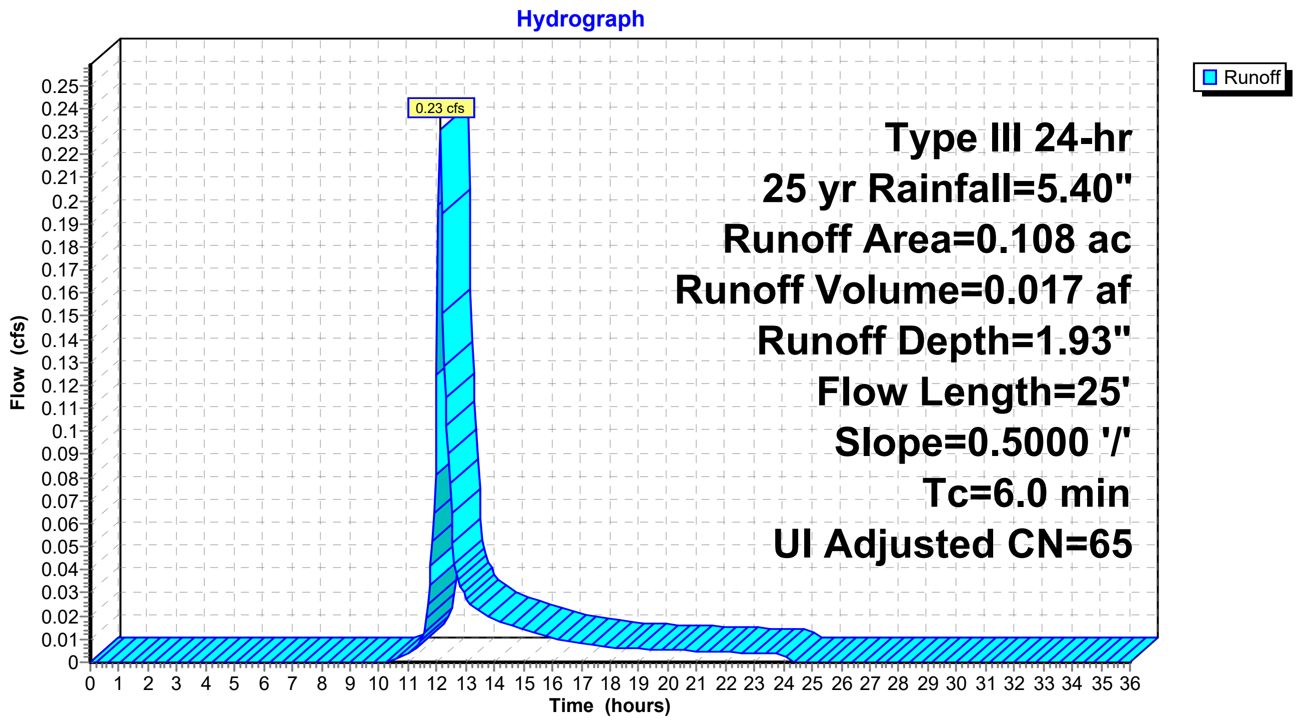
Runoff = 0.23 cfs @ 12.10 hrs, Volume= 0.017 af, Depth= 1.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.40"

Area (ac)	CN	Adj	Description
0.025	98		Unconnected pavement, HSG B
0.083	61		>75% Grass cover, Good, HSG B
0.108	70	65	Weighted Average, UI Adjusted
0.083			76.85% Pervious Area
0.025			23.15% Impervious Area
0.025			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.3	25	0.5000	0.32		**Sheet Flow, SLOPING LAND** Grass: Dense n= 0.240 P2= 3.20"
1.3	25	Total, Increased to minimum Tc = 6.0 min			

Subcatchment PR-4C: SB 00 DPW SLOPE



Summary for Subcatchment PR-5A: BB 01 A

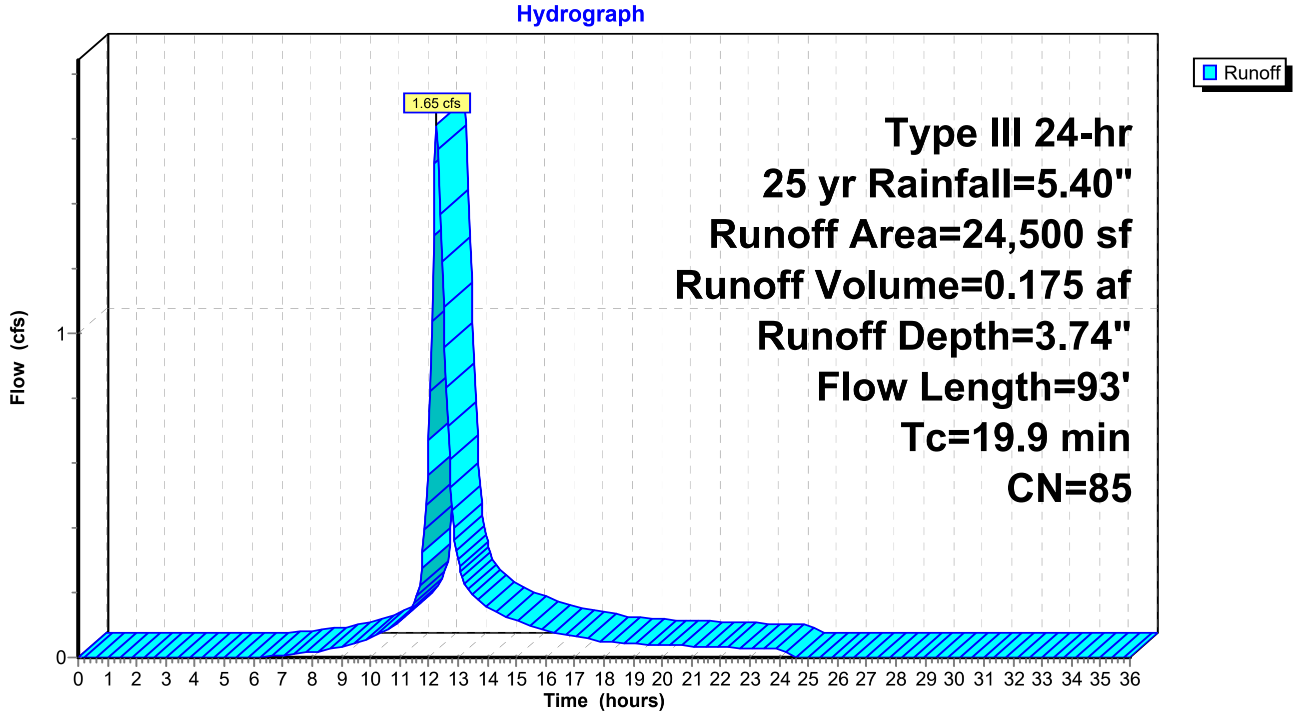
Runoff = 1.65 cfs @ 12.27 hrs, Volume= 0.175 af, Depth= 3.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.40"

	Area (sf)	CN	Description
*	24,500	85	SYNTHETIC TURF- PAD- LINER
	24,500		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.2	46	0.0067	0.04		**Sheet Flow, Through Turf Section** Grass: Bermuda n= 0.410 P2= 3.20"
1.7	47	0.0001	0.45	0.16	**Pipe Channel, TRENCH DRAIN LEVEL** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010
19.9	93	Total			

Subcatchment PR-5A: BB 01 A



Summary for Subcatchment PR-5B: BB 11 A

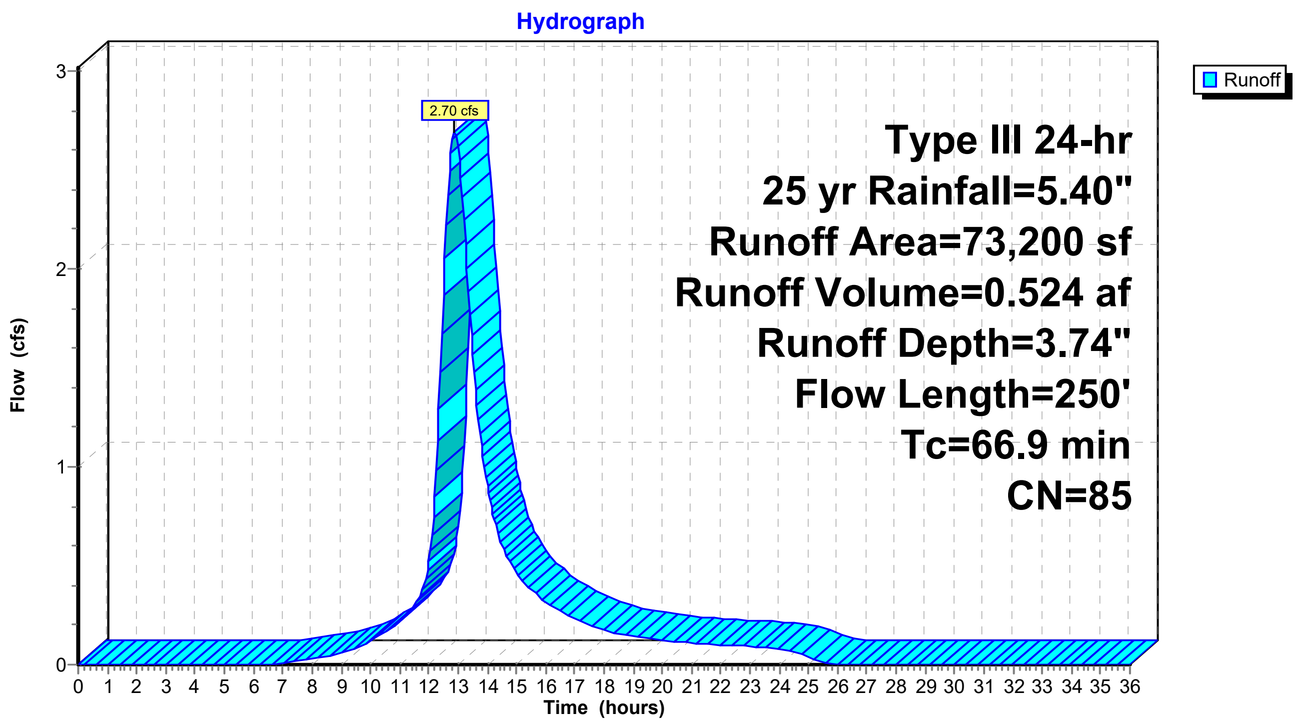
Runoff = 2.70 cfs @ 12.87 hrs, Volume= 0.524 af, Depth= 3.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.40"

	Area (sf)	CN	Description
*	73,200	85	SYNTHETIC TURF- PAD- LINER
	73,200		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.1	53	0.0055	0.04		**Sheet Flow, Through Turf Section** Grass: Bermuda n= 0.410 P2= 3.20"
43.1	150	0.0083	0.06		**Sheet Flow, SYNTHETIC TURF** Grass: Bermuda n= 0.410 P2= 3.20"
1.7	47	0.0001	0.45	0.16	**Pipe Channel, TRENCH DRAIN LEVEL** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010
66.9	250	Total			

Subcatchment PR-5B: BB 11 A



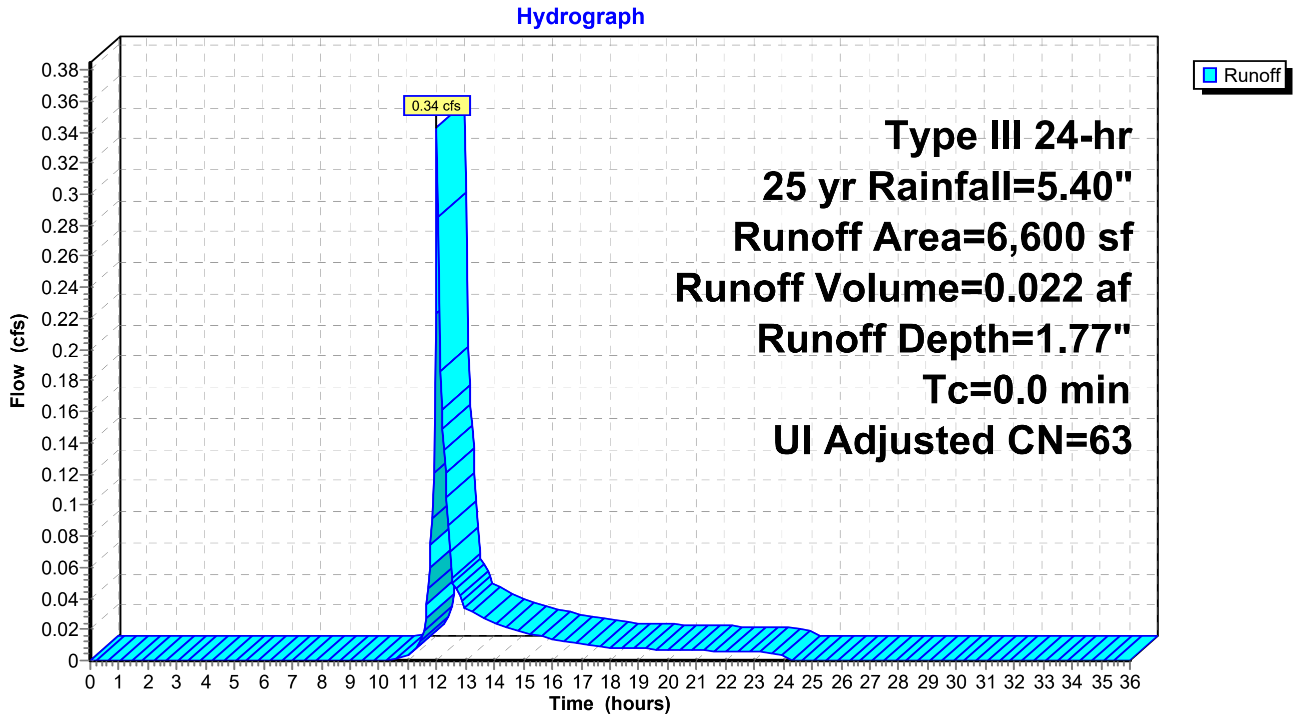
Summary for Subcatchment PR-5C: SLOPE

Runoff = 0.34 cfs @ 12.01 hrs, Volume= 0.022 af, Depth= 1.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=5.40"

Area (sf)	CN	Adj	Description
600	98		Unconnected roofs, HSG B
6,000	61		>75% Grass cover, Good, HSG B
6,600	64	63	Weighted Average, UI Adjusted
6,000			90.91% Pervious Area
600			9.09% Impervious Area
600			100.00% Unconnected

Subcatchment PR-5C: SLOPE



Summary for Pond 1P: rain garden#1 cascading

Inflow Area = 0.725 ac, 65.66% Impervious, Inflow Depth = 3.74" for 25 yr event
Inflow = 3.07 cfs @ 12.09 hrs, Volume= 0.226 af
Outflow = 2.85 cfs @ 12.11 hrs, Volume= 0.224 af, Atten= 7%, Lag= 1.4 min
Primary = 2.75 cfs @ 12.12 hrs, Volume= 0.223 af
Secondary = 0.11 cfs @ 12.10 hrs, Volume= 0.001 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 62.02' @ 12.12 hrs Surf.Area= 507 sf Storage= 563 cf
Flood Elev= 63.00' Surf.Area= 660 sf Storage= 1,132 cf

Plug-Flow detention time= 39.9 min calculated for 0.224 af (99% of inflow)
Center-of-Mass det. time= 35.5 min (840.1 - 804.6)

Volume	Invert	Avail.Storage	Storage Description
#1	58.50'	1,048 cf	**Rain Garden Envelope (Prismatic)**Listed below (Recalc) 1,348 cf Overall - 300 cf Embedded = 1,048 cf
#2	58.50'	30 cf	**crush stone (Prismatic)**Listed below (Recalc) Inside #1 75 cf Overall x 40.0% Voids
#3	59.00'	50 cf	**Bio Media (Prismatic)**Listed below (Recalc) Inside #1 199 cf Overall x 25.0% Voids
#4	60.33'	5 cf	**Mulch (Prismatic)**Listed below (Recalc) Inside #1 26 cf Overall x 20.0% Voids
		1,132 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
58.50	150	0	0
60.50	150	300	300
61.00	236	97	397
62.00	503	370	766
63.00	660	582	1,348

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
58.50	150	0	0
59.00	150	75	75

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
59.00	150	0	0
60.33	150	199	199

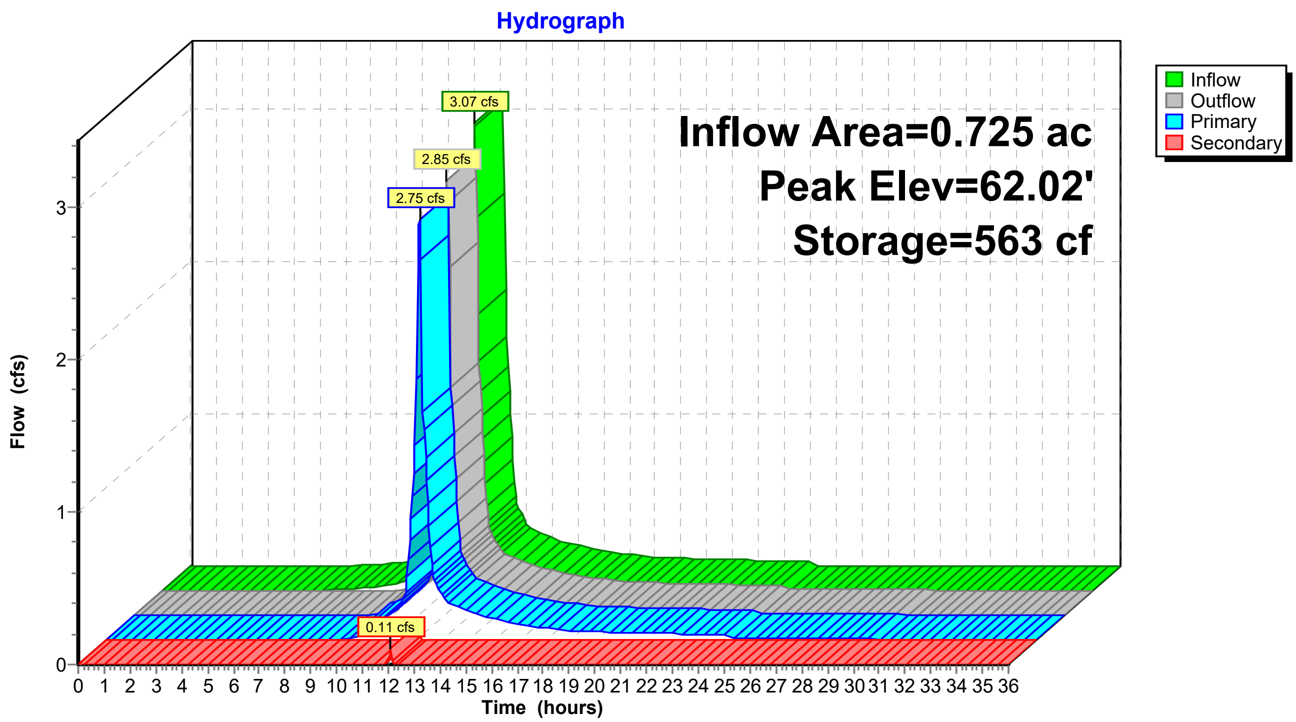
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
60.33	150	0	0
60.50	150	26	26

Device	Routing	Invert	Outlet Devices
#1	Device 3	58.50'	**1.020 in/hr Exfiltration over Surface area**
#2	Secondary	62.00'	**25.0' long x 3.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32
#3	Primary	58.50'	**8.0" Round Culvert** L= 20.0' Ke= 0.500 Inlet / Outlet Invert= 58.50' / 58.40' S= 0.0050 '/' Cc= 0.900 n= 0.012, Flow Area= 0.35 sf
#4	Device 3	61.50'	**12.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=2.71 cfs @ 12.12 hrs HW=62.01' TW=54.38' (Dynamic Tailwater)
└─**3=Culvert** (Passes 2.71 cfs of 3.00 cfs potential flow)
  ├─**1=Exfiltration** (Exfiltration Controls 0.01 cfs)
  └─**4=Orifice/Grate** (Orifice Controls 2.70 cfs @ 3.44 fps)

Secondary OutFlow Max=0.10 cfs @ 12.10 hrs HW=62.01' TW=54.35' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir** (Weir Controls 0.10 cfs @ 0.29 fps)

Pond 1P: rain garden#1 cascading



Summary for Pond 2P: rain garden#2 cascading

Inflow Area = 0.966 ac, 61.39% Impervious, Inflow Depth > 3.57" for 25 yr event
Inflow = 3.71 cfs @ 12.11 hrs, Volume= 0.287 af
Outflow = 3.19 cfs @ 12.17 hrs, Volume= 0.280 af, Atten= 14%, Lag= 3.9 min
Primary = 3.19 cfs @ 12.17 hrs, Volume= 0.280 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 54.45' @ 12.17 hrs Surf.Area= 978 sf Storage= 1,150 cf
Flood Elev= 55.00' Surf.Area= 1,326 sf Storage= 1,784 cf

Plug-Flow detention time= 58.3 min calculated for 0.280 af (97% of inflow)
Center-of-Mass det. time= 37.4 min (873.3 - 835.9)

Volume	Invert	Avail.Storage	Storage Description
#1	51.00'	1,557 cf	**Rain Garden Envelope (Prismatic)**Listed below (Recalc) 2,357 cf Overall - 800 cf Embedded = 1,557 cf
#2	51.00'	80 cf	**crush stone (Prismatic)**Listed below (Recalc) Inside #1 200 cf Overall x 40.0% Voids
#3	51.50'	133 cf	**Bio Media (Prismatic)**Listed below (Recalc) Inside #1 532 cf Overall x 25.0% Voids
#4	52.83'	14 cf	**Mulch (Prismatic)**Listed below (Recalc) Inside #1 68 cf Overall x 20.0% Voids
		1,784 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
51.00	400	0	0
53.00	400	800	800
54.00	694	547	1,347
55.00	1,326	1,010	2,357

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
51.00	400	0	0
51.50	400	200	200

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
51.50	400	0	0
52.83	400	532	532

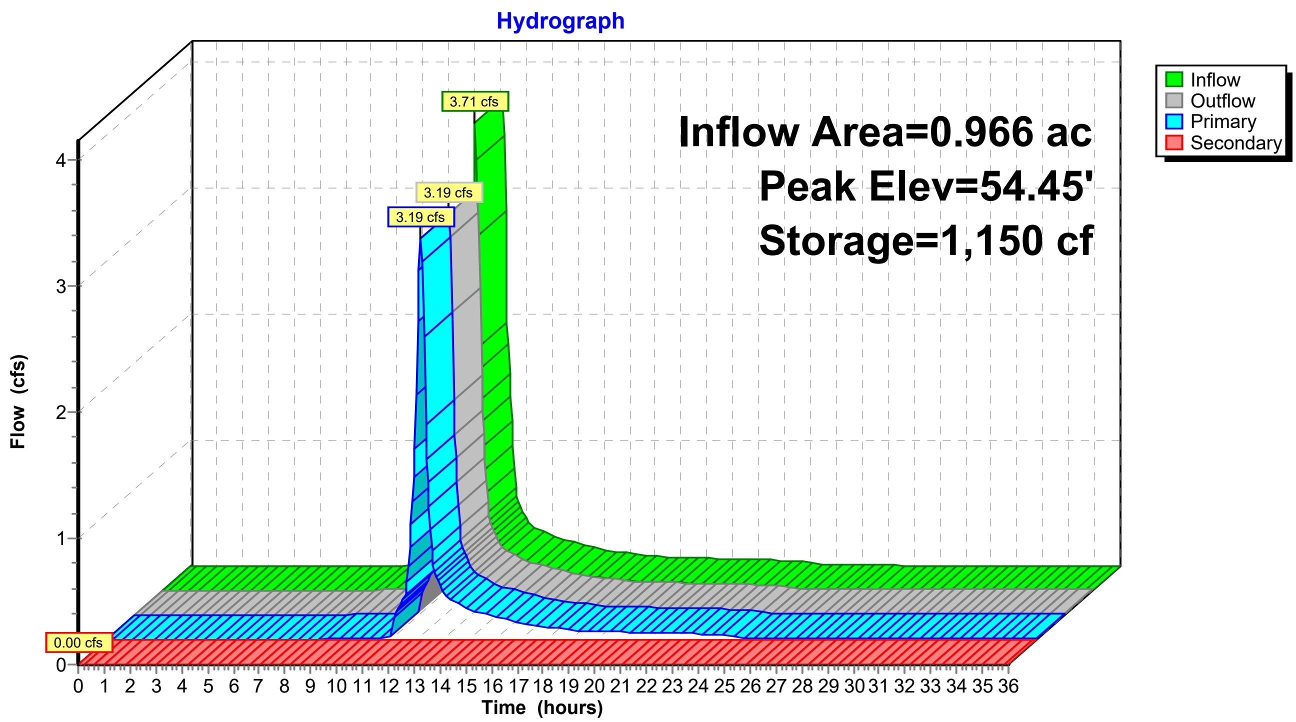
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
52.83	400	0	0
53.00	400	68	68

Device	Routing	Invert	Outlet Devices
#1	Device 3	51.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Secondary	54.50'	**25.0' long x 3.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32
#3	Primary	51.00'	**12.0" Round Culvert** L= 25.0' Ke= 0.500 Inlet / Outlet Invert= 51.00' / 50.88' S= 0.0048 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf
#4	Device 3	53.75'	**12.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=3.16 cfs @ 12.17 hrs HW=54.44' TW=48.95' (Dynamic Tailwater)
3=Culvert (Passes 3.16 cfs of 6.48 cfs potential flow)
1=Exfiltration (Exfiltration Controls 0.02 cfs)
4=Orifice/Grate (Orifice Controls 3.13 cfs @ 3.99 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=51.00' TW=46.00' (Dynamic Tailwater)
2=Broad-Crested Rectangular Weir(Controls 0.00 cfs)

Pond 2P: rain garden#2 cascading



Summary for Pond 3P: rain garden#3 cascading

Inflow Area = 1.153 ac, 51.43% Impervious, Inflow Depth > 3.18" for 25 yr event
Inflow = 3.45 cfs @ 12.16 hrs, Volume= 0.305 af
Outflow = 3.44 cfs @ 12.17 hrs, Volume= 0.291 af, Atten= 0%, Lag= 0.6 min
Primary = 3.44 cfs @ 12.17 hrs, Volume= 0.291 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 48.95' @ 12.17 hrs Surf.Area= 938 sf Storage= 1,068 cf
Flood Elev= 50.00' Surf.Area= 1,373 sf Storage= 2,283 cf

Plug-Flow detention time= 76.4 min calculated for 0.290 af (95% of inflow)
Center-of-Mass det. time= 34.2 min (906.9 - 872.8)

Volume	Invert	Avail.Storage	Storage Description
#1	46.00'	1,944 cf	**Rain Garden Envelope (Prismatic)**Listed below (Recalc) 3,144 cf Overall - 1,200 cf Embedded = 1,944 cf
#2	46.00'	120 cf	**crush stone (Prismatic)**Listed below (Recalc) Inside #1 300 cf Overall x 40.0% Voids
#3	46.50'	199 cf	**Bio Media (Prismatic)**Listed below (Recalc) Inside #1 798 cf Overall x 25.0% Voids
#4	47.83'	20 cf	**Mulch (Prismatic)**Listed below (Recalc) Inside #1 102 cf Overall x 20.0% Voids
		2,283 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
46.00	600	0	0
48.00	600	1,200	1,200
49.00	957	779	1,979
50.00	1,373	1,165	3,144

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
46.00	600	0	0
46.50	600	300	300

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
46.50	600	0	0
47.83	600	798	798

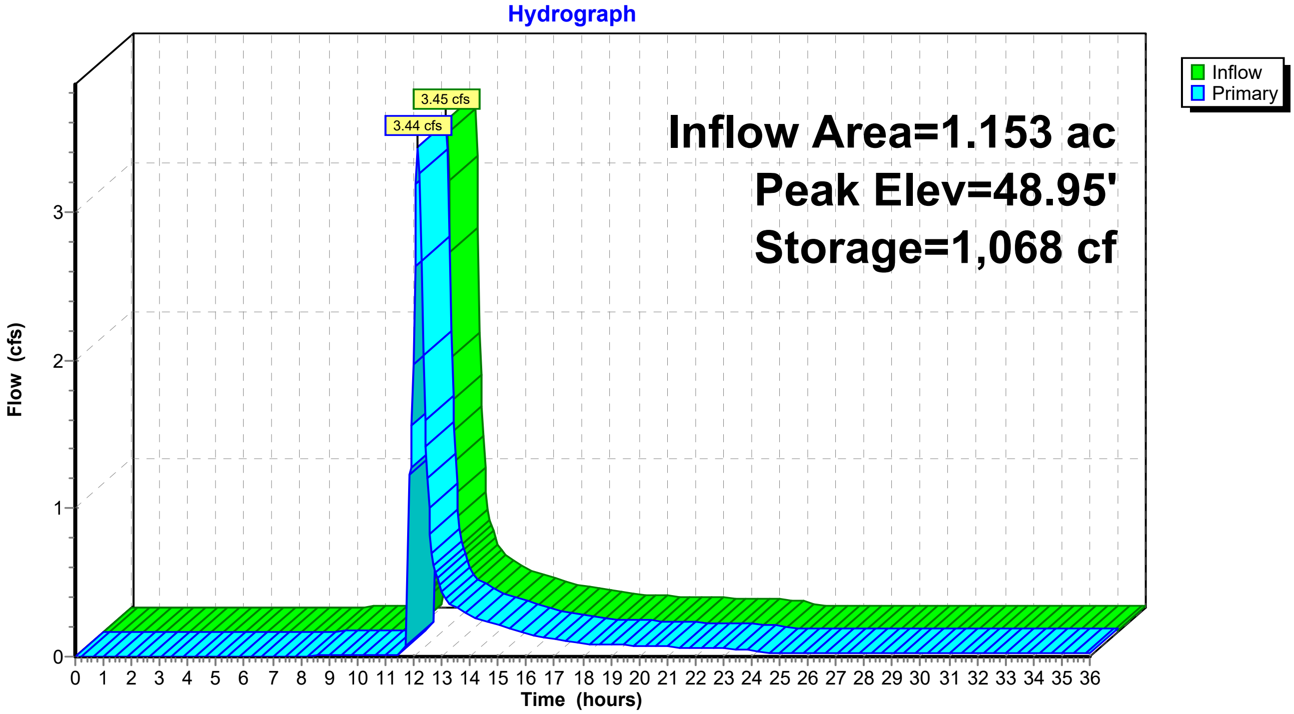
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
47.83	600	0	0
48.00	600	102	102

Device	Routing	Invert	Outlet Devices
#1	Device 3	46.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Device 3	48.75'	**24.0" x 48.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

#3	Primary	46.00'	**15.0" Round Culvert** L= 26.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 46.00' / 45.87' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf

Primary OutFlow Max=3.41 cfs @ 12.17 hrs HW=48.95' TW=0.00' (Dynamic Tailwater)
└─**3=Culvert** (Passes 3.41 cfs of 7.11 cfs potential flow)
  ├─**1=Exfiltration** (Exfiltration Controls 0.02 cfs)
  └─**2=Orifice/Grate** (Weir Controls 3.39 cfs @ 1.45 fps)

Pond 3P: rain garden#3 cascading



Summary for Pond 4P: UGS-1

Inflow Area = 1.685 ac, 60.12% Impervious, Inflow Depth = 3.61" for 25 yr event
Inflow = 6.78 cfs @ 12.09 hrs, Volume= 0.507 af
Outflow = 5.39 cfs @ 12.16 hrs, Volume= 0.487 af, Atten= 21%, Lag= 4.0 min
Discarded = 0.04 cfs @ 8.30 hrs, Volume= 0.101 af
Primary = 5.35 cfs @ 12.16 hrs, Volume= 0.386 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 43.29' @ 12.16 hrs Surf.Area= 1,672 sf Storage= 4,180 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 104.6 min (905.8 - 801.1)

Volume	Invert	Avail.Storage	Storage Description
#1A	39.50'	2,099 cf	**29.92'W x 55.89'L x 5.50'H Field A** 9,196 cf Overall - 3,198 cf Embedded = 5,998 cf x 35.0% Voids
#2A	40.25'	3,198 cf	**ADS_StormTech MC-3500 d +Cap** x 28 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap 28 Chambers in 4 Rows Cap Storage= +14.9 cf x 2 x 4 rows = 119.2 cf
		5,297 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	39.50'	**24.0" Round Culvert** L= 50.0' Ke= 0.500 Inlet / Outlet Invert= 39.50' / 39.00' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf
#2	Device 1	43.60'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Discarded	39.50'	**1.020 in/hr Exfiltration over Surface area**
#4	Device 1	41.83'	**8.0" Vert. Orifice/Grate X 3.00** C= 0.600

Discarded OutFlow Max=0.04 cfs @ 8.30 hrs HW=39.56' (Free Discharge)
└─**3=Exfiltration** (Exfiltration Controls 0.04 cfs)

Primary OutFlow Max=5.31 cfs @ 12.16 hrs HW=43.27' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Passes 5.31 cfs of 25.19 cfs potential flow)
  ├─**2=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)
  └─**4=Orifice/Grate** (Orifice Controls 5.31 cfs @ 5.07 fps)

Pond 4P: UGS-1 - Chamber Wizard Field A

Chamber Model = ADS_StormTechMC-3500 d +Cap (ADS StormTech®MC-3500 d rev 03/14 with Cap volume)
Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf
Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap
Cap Storage= +14.9 cf x 2 x 4 rows = 119.2 cf

77.0" Wide + 9.0" Spacing = 86.0" C-C Row Spacing

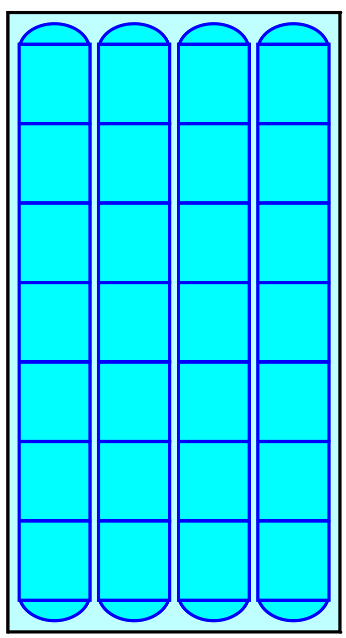
7 Chambers/Row x 7.17' Long +1.85' Cap Length x 2 = 53.89' Row Length +12.0" End Stone x 2 = 55.89' Base Length
4 Rows x 77.0" Wide + 9.0" Spacing x 3 + 12.0" Side Stone x 2 = 29.92' Base Width
9.0" Base + 45.0" Chamber Height + 12.0" Cover = 5.50' Field Height

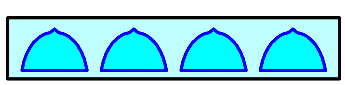
28 Chambers x 110.0 cf + 14.9 cf Cap Volume x 2 x 4 Rows = 3,197.9 cf Chamber Storage

9,196.2 cf Field - 3,197.9 cf Chambers = 5,998.4 cf Stone x 35.0% Voids = 2,099.4 cf Stone Storage

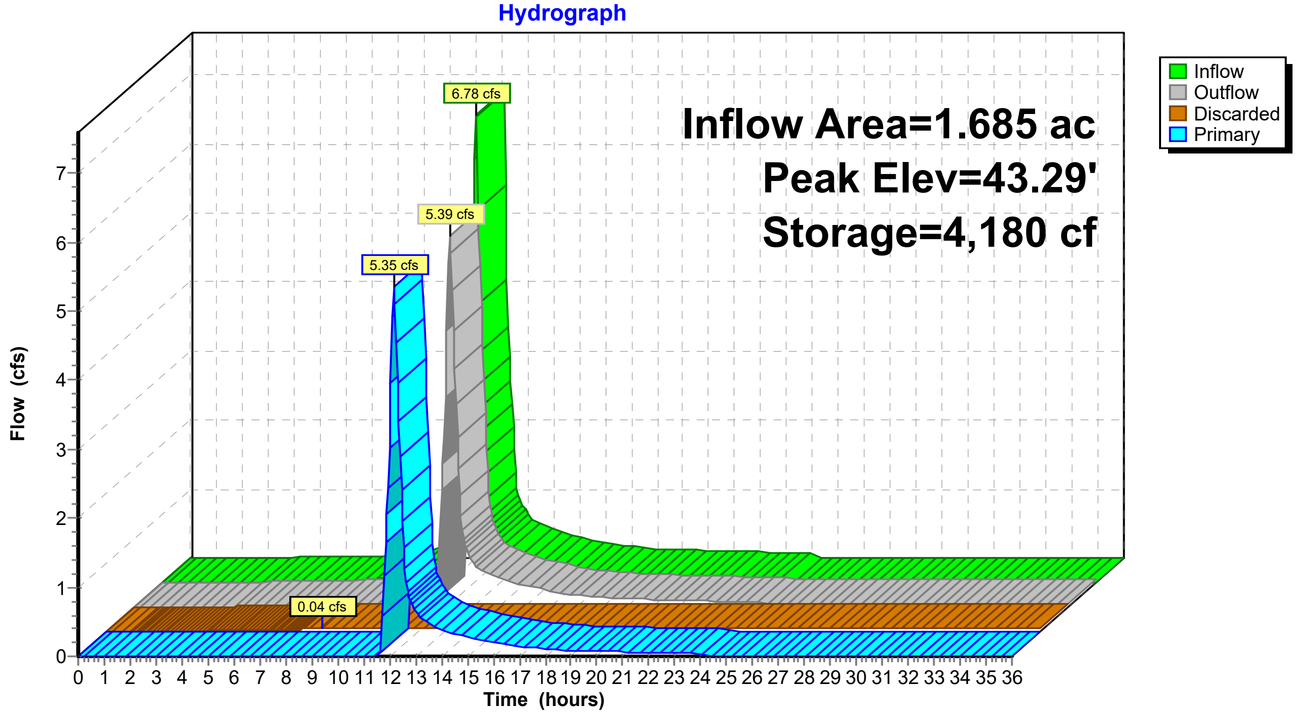
Chamber Storage + Stone Storage = 5,297.3 cf = 0.122 af
Overall Storage Efficiency = 57.6%
Overall System Size = 55.89' x 29.92' x 5.50'

28 Chambers
340.6 cy Field
222.2 cy Stone





Pond 4P: UGS-1


Hydrograph
Inflow
Outflow
Discarded
Primary
Inflow Area=1.685 ac
Peak Elev=43.29'
Storage=4,180 cf
6.78 cfs
5.39 cfs
5.35 cfs
0.04 cfs
Flow (cfs)
Time (hours)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36
0 1 2 3 4 5 6 7

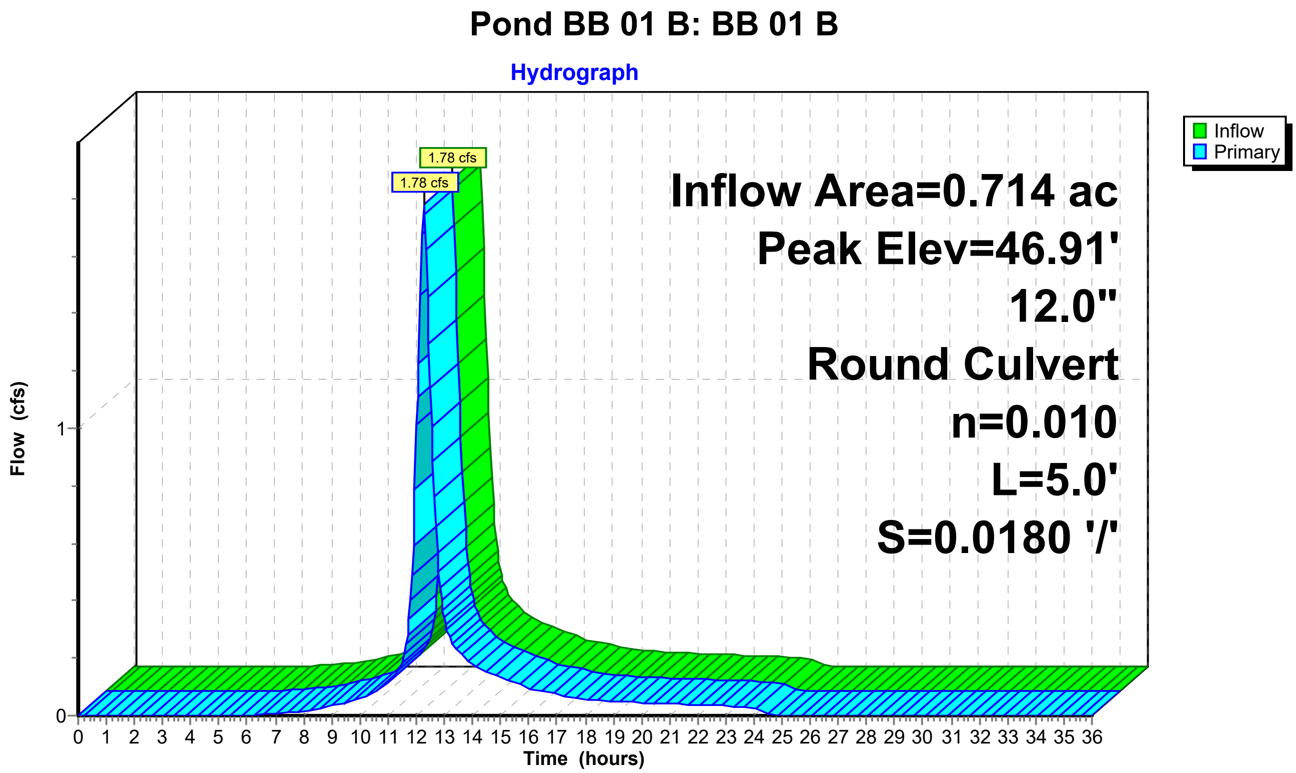
Summary for Pond BB 01 B: BB 01 B

Inflow Area =	0.714 ac,	1.93% Impervious, Inflow Depth = 3.32"	for 25 yr event	
Inflow =	1.78 cfs @	12.26 hrs, Volume=	0.198 af	
Outflow =	1.78 cfs @	12.26 hrs, Volume=	0.198 af,	Atten= 0%, Lag= 0.0 min
Primary =	1.78 cfs @	12.26 hrs, Volume=	0.198 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 46.91' @ 12.59 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	45.90'	**12.0" Round Culvert** L= 5.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 45.90' / 45.81' S= 0.0180 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=1.74 cfs @ 12.26 hrs HW=46.72' TW=46.43' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 1.74 cfs @ 3.43 fps)



Summary for Pond BB 01 S: BB 01 S

Inflow Area = 0.714 ac, 1.93% Impervious, Inflow Depth = 3.32" for 25 yr event
Inflow = 1.78 cfs @ 12.26 hrs, Volume= 0.198 af
Outflow = 0.91 cfs @ 12.59 hrs, Volume= 0.198 af, Atten= 49%, Lag= 19.5 min
Primary = 0.91 cfs @ 12.59 hrs, Volume= 0.198 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 46.86' @ 12.59 hrs Surf.Area= 0 sf Storage= 2,045 cf

Plug-Flow detention time= 25.1 min calculated for 0.198 af (100% of inflow)
Center-of-Mass det. time= 24.6 min (846.5 - 821.8)

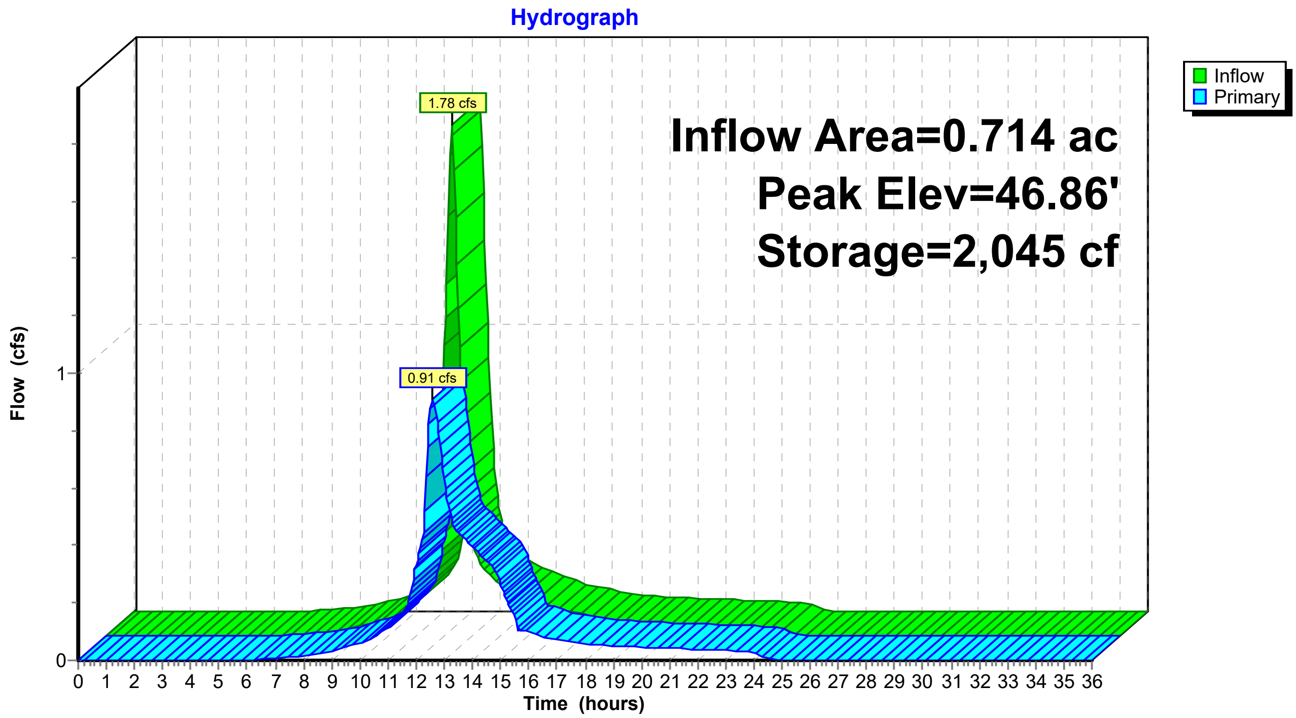
Volume	Invert	Avail.Storage	Storage Description
#1	44.97'	3,256 cf	**Custom Stage Data**Listed below

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
44.97	0	0
45.30	16	16
45.80	236	252
46.30	825	1,077
46.80	876	1,953
47.30	792	2,745
47.80	511	3,256

Device	Routing	Invert	Outlet Devices
#1	Primary	44.97'	**4.0" Round Culvert** L= 8.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 44.97' / 44.87' S= 0.0125 '/' Cc= 0.900 n= 0.010, Flow Area= 0.09 sf
#2	Primary	46.40'	**6.0" Round Culvert** L= 5.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 46.40' / 46.30' S= 0.0200 '/' Cc= 0.900 n= 0.010, Flow Area= 0.20 sf

Primary OutFlow Max=0.91 cfs @ 12.59 hrs HW=46.86' TW=45.46' (Dynamic Tailwater)
—**1=Culvert** (Inlet Controls 0.50 cfs @ 5.69 fps)
—**2=Culvert** (Barrel Controls 0.41 cfs @ 2.86 fps)

Pond BB 01 S: BB 01 S



Summary for Pond BB 06 B: BB 06 B

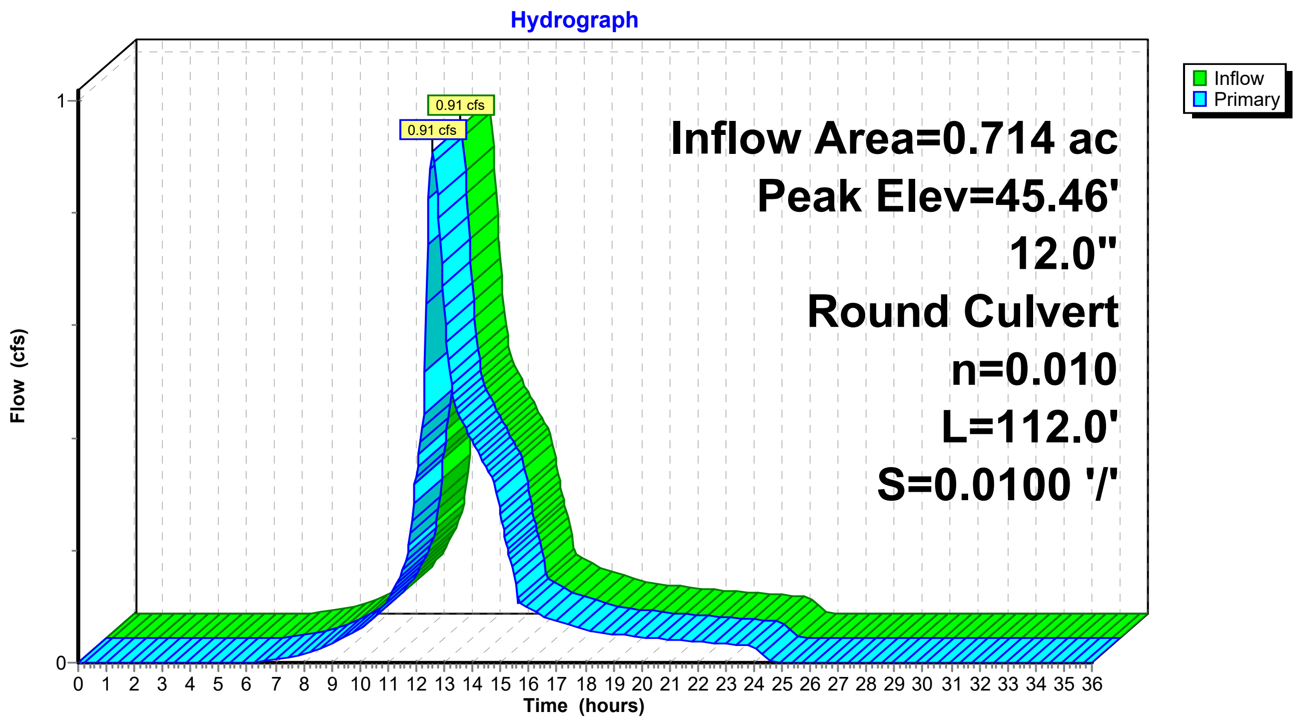
Inflow Area =	0.714 ac,	1.93% Impervious,	Inflow Depth = 3.32"	for 25 yr event	
Inflow =	0.91 cfs @	12.59 hrs,	Volume=	0.198 af	
Outflow =	0.91 cfs @	12.59 hrs,	Volume=	0.198 af,	Atten= 0%, Lag= 0.0 min
Primary =	0.91 cfs @	12.59 hrs,	Volume=	0.198 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 45.46' @ 12.59 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	44.97'	**12.0" Round Culvert** L= 112.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 44.97' / 43.85' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=0.91 cfs @ 12.59 hrs HW=45.46' TW=43.22' (Dynamic Tailwater)
1=Culvert (Inlet Controls 0.91 cfs @ 2.38 fps)

Pond BB 06 B: BB 06 B



Summary for Pond BB 11 B: BB 11 B

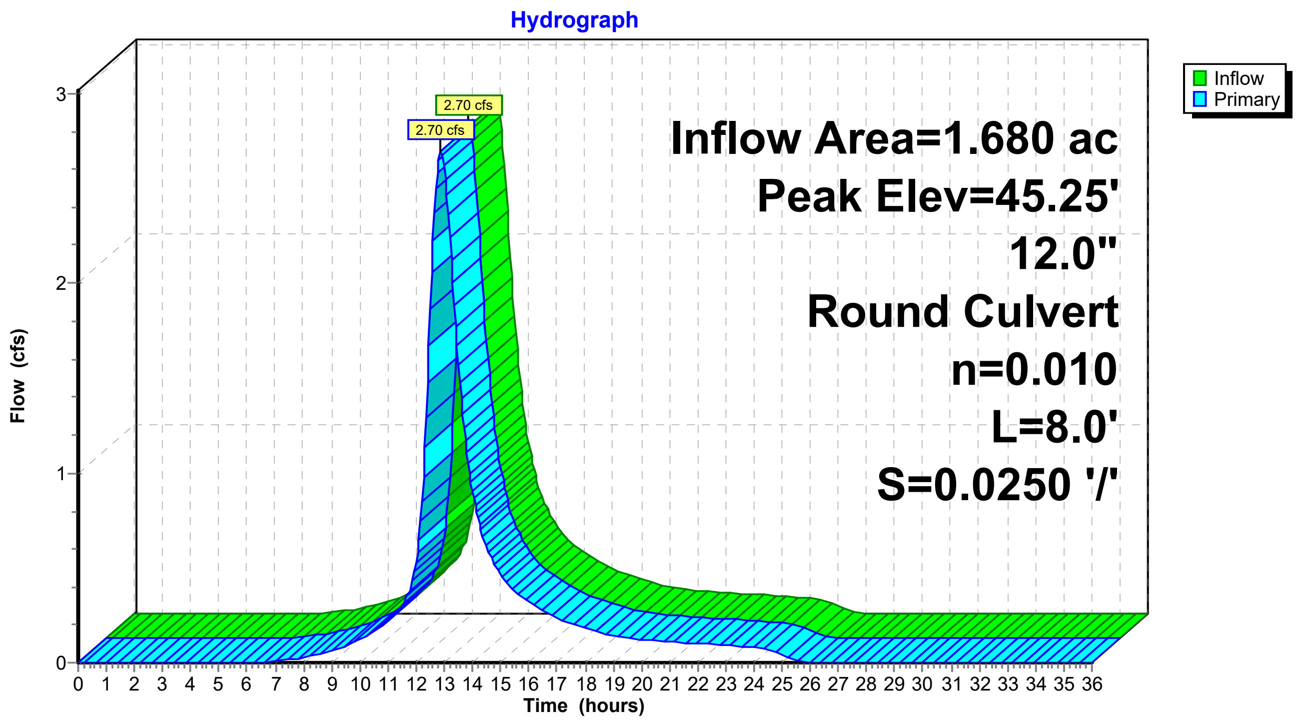
Inflow Area =	1.680 ac,	0.00% Impervious, Inflow Depth = 3.74"	for 25 yr event	
Inflow =	2.70 cfs @	12.87 hrs, Volume=	0.524 af	
Outflow =	2.70 cfs @	12.87 hrs, Volume=	0.524 af,	Atten= 0%, Lag= 0.0 min
Primary =	2.70 cfs @	12.87 hrs, Volume=	0.524 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 45.25' @ 13.15 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	44.00'	**12.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 44.00' / 43.80' S= 0.0250 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=2.57 cfs @ 12.87 hrs HW=45.01' TW=44.55' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 2.57 cfs @ 3.27 fps)

Pond BB 11 B: BB 11 B



Summary for Pond BB 11 S: BB 11 S

Inflow Area = 1.680 ac, 0.00% Impervious, Inflow Depth = 3.74" for 25 yr event
Inflow = 2.70 cfs @ 12.87 hrs, Volume= 0.524 af
Outflow = 2.14 cfs @ 13.24 hrs, Volume= 0.524 af, Atten= 21%, Lag= 22.4 min
Primary = 2.14 cfs @ 13.24 hrs, Volume= 0.524 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 44.91' @ 13.24 hrs Surf.Area= 0 sf Storage= 2,716 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 10.0 min (871.0 - 861.0)

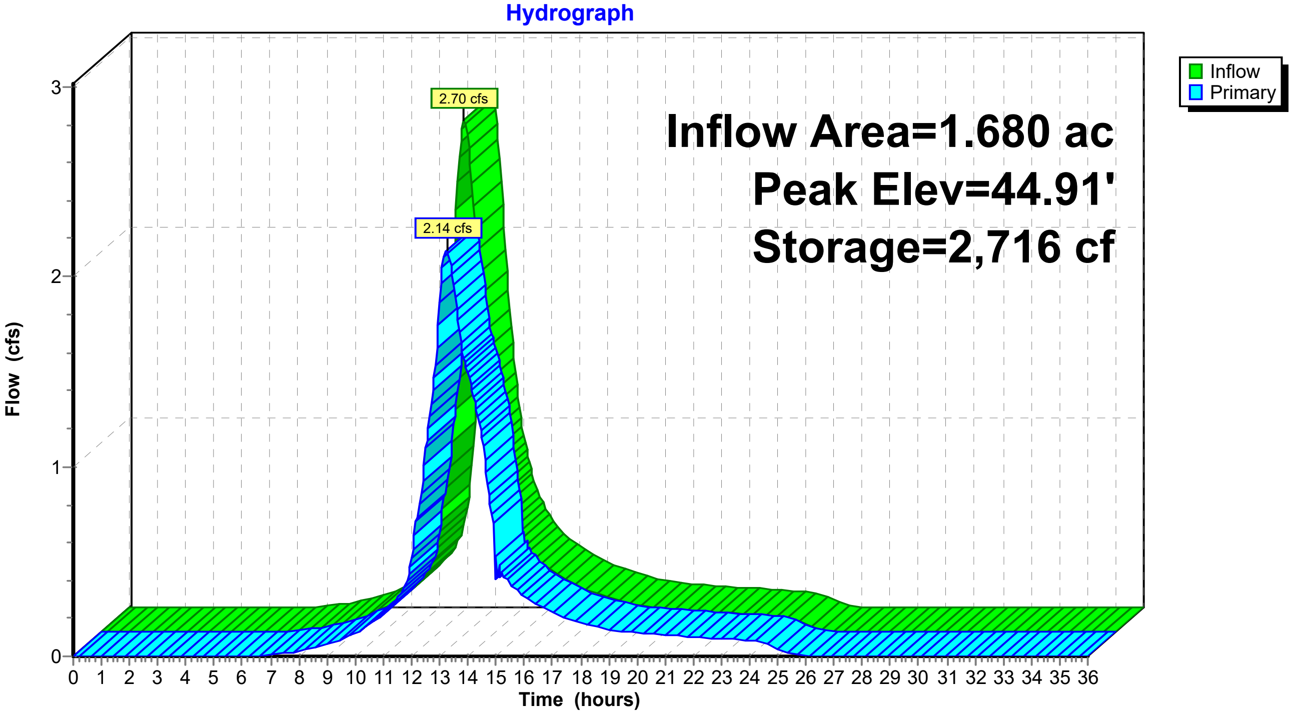
Volume	Invert	Avail.Storage	Storage Description
#1	42.97'	4,778 cf	**Custom Stage Data**Listed below

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
42.97	0	0
43.30	16	16
43.80	481	497
44.30	963	1,460
44.80	1,019	2,479
45.30	1,085	3,564
45.80	603	4,167
46.30	611	4,778

Device	Routing	Invert	Outlet Devices
#1	Primary	42.97'	**4.0" Round Culvert** L= 16.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 42.97' / 42.81' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.09 sf
#2	Primary	39.70'	**6.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 39.70' / 39.60' S= 0.0125 '/' Cc= 0.900 n= 0.010, Flow Area= 0.20 sf
#3	Primary	44.50'	**8.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 44.50' / 44.40' S= 0.0125 '/' Cc= 0.900 n= 0.010, Flow Area= 0.35 sf

Primary OutFlow Max=2.14 cfs @ 13.24 hrs HW=44.91' TW=43.32' (Dynamic Tailwater)
├─**1=Culvert** (Outlet Controls 0.53 cfs @ 6.06 fps)
├─**2=Culvert** (Inlet Controls 1.19 cfs @ 6.07 fps)
└─**3=Culvert** (Barrel Controls 0.42 cfs @ 2.71 fps)

Pond BB 11 S: BB 11 S



Summary for Pond PR-4: PR-4

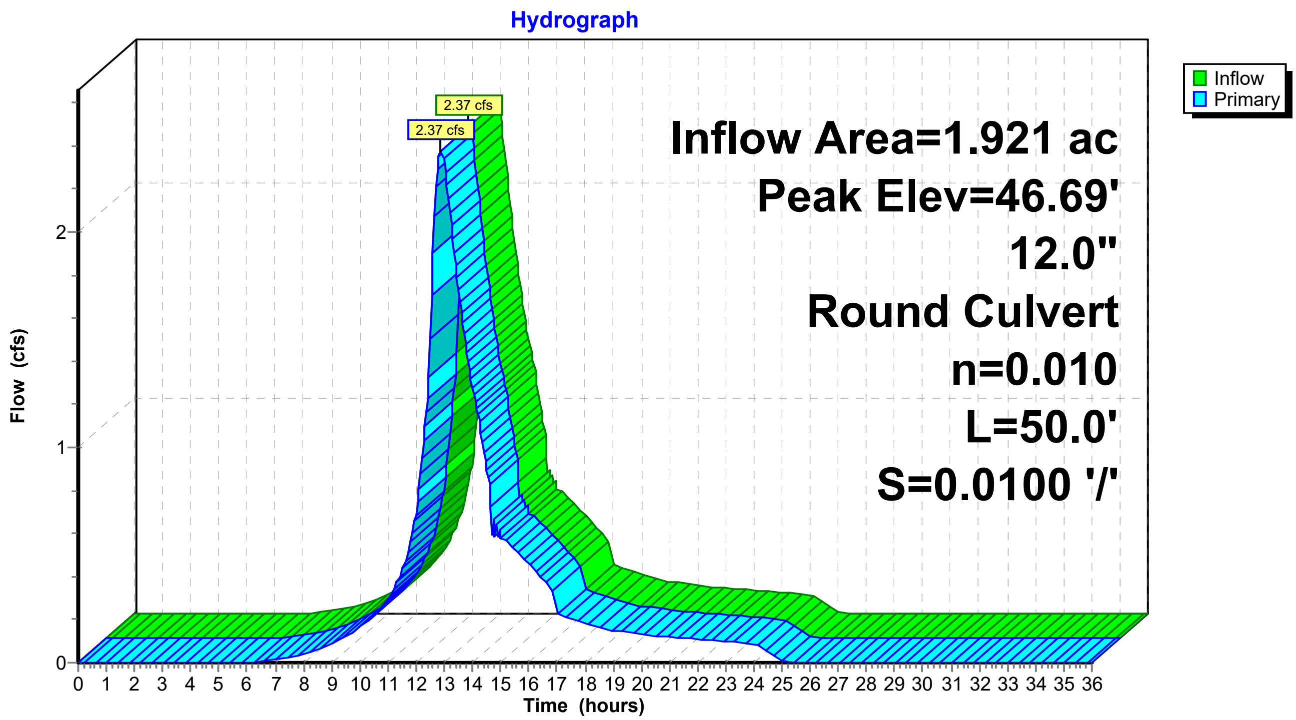
Inflow Area =	1.921 ac,	1.30% Impervious, Inflow Depth =	3.64"	for 25 yr event
Inflow =	2.37 cfs @	12.88 hrs, Volume=	0.582 af	
Outflow =	2.37 cfs @	12.88 hrs, Volume=	0.582 af,	Atten= 0%, Lag= 0.0 min
Primary =	2.37 cfs @	12.88 hrs, Volume=	0.582 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 46.69' @ 12.88 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	45.80'	**12.0" Round Culvert** L= 50.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 45.80' / 45.30' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=2.37 cfs @ 12.88 hrs HW=46.69' TW=0.00' (Dynamic Tailwater)
↑**1=Culvert** (Inlet Controls 2.37 cfs @ 3.21 fps)

Pond PR-4: PR-4



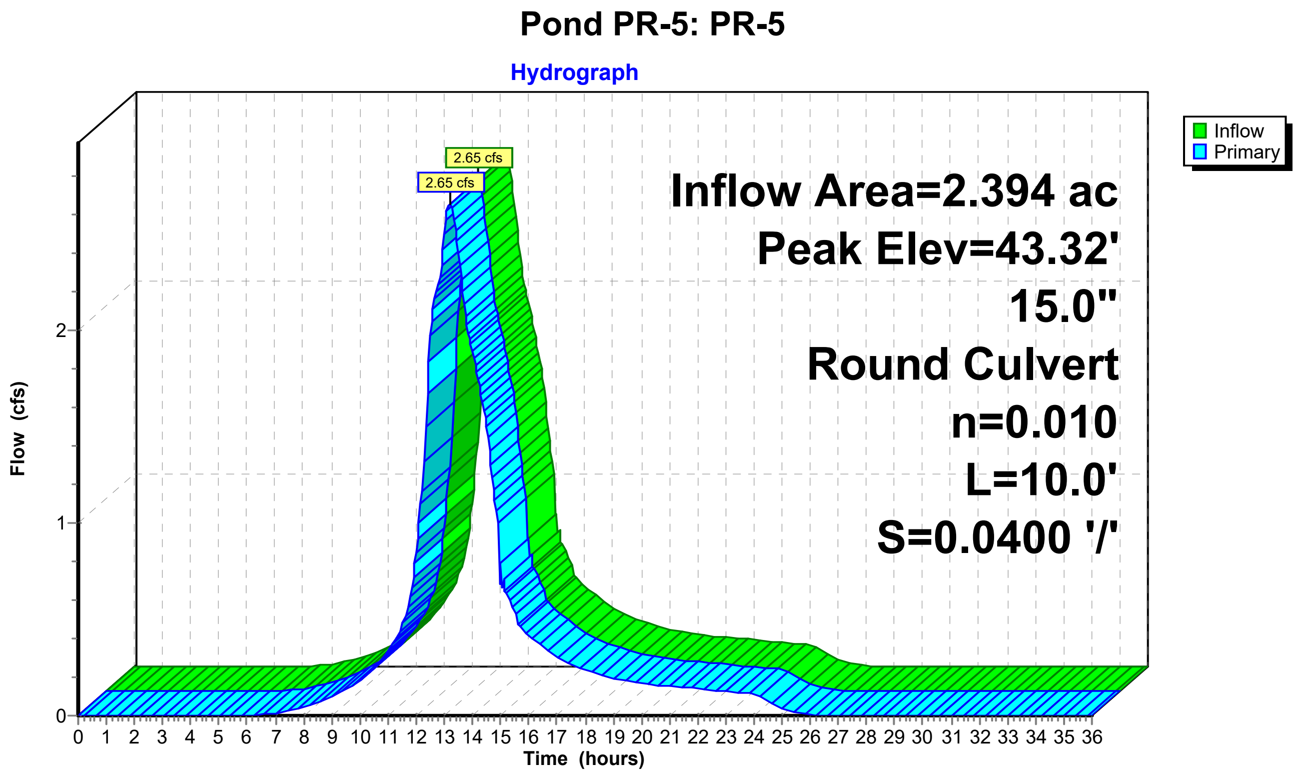
Summary for Pond PR-5: PR-5

Inflow Area =	2.394 ac,	0.58% Impervious,	Inflow Depth = 3.61"	for 25 yr event	
Inflow =	2.65 cfs @	13.19 hrs,	Volume=	0.721 af	
Outflow =	2.65 cfs @	13.19 hrs,	Volume=	0.721 af,	Atten= 0%, Lag= 0.0 min
Primary =	2.65 cfs @	13.19 hrs,	Volume=	0.721 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 43.32' @ 13.19 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	42.50'	**15.0" Round Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 42.50' / 42.10' S= 0.0400 '/' Cc= 0.900 n= 0.010, Flow Area= 1.23 sf

Primary OutFlow Max=2.65 cfs @ 13.19 hrs HW=43.32' TW=0.00' (Dynamic Tailwater)
1=Culvert (Inlet Controls 2.65 cfs @ 3.09 fps)



Summary for Pond SB 01 B: SB 01 B

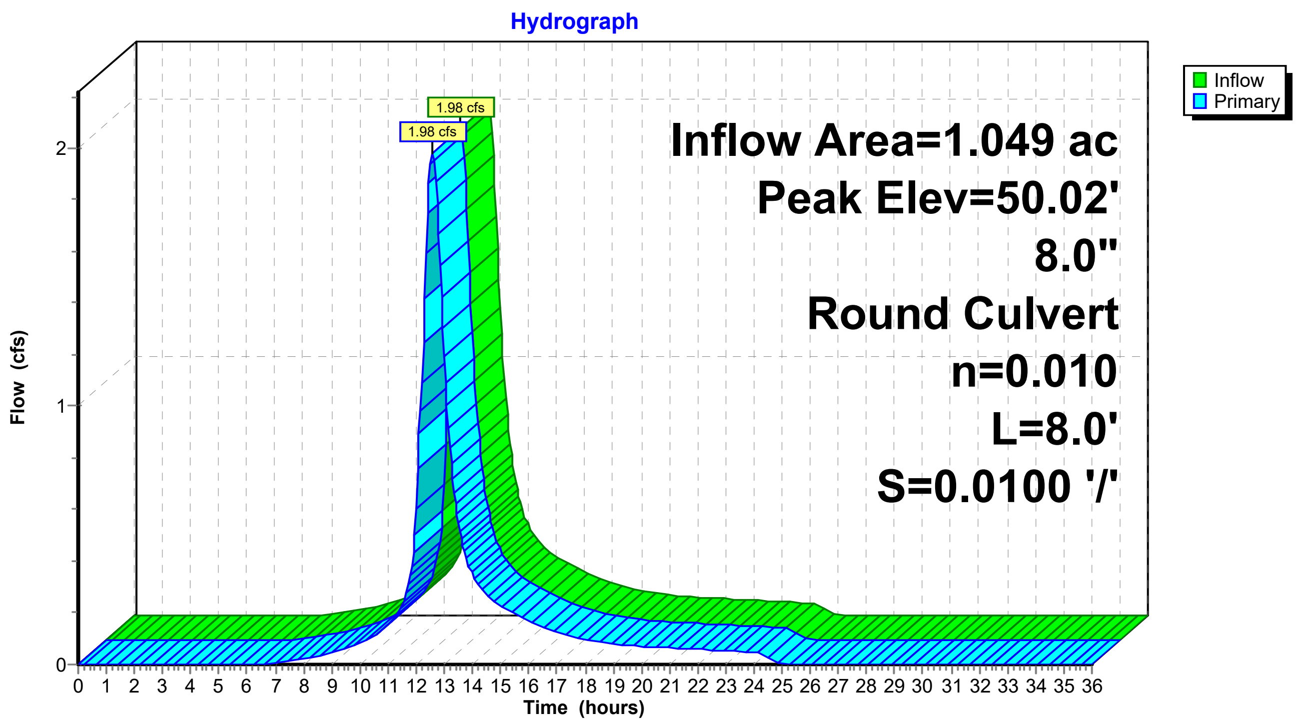
Inflow Area = 1.049 ac, 2.38% Impervious, Inflow Depth = 3.55" for 25 yr event
Inflow = 1.98 cfs @ 12.57 hrs, Volume= 0.311 af
Outflow = 1.98 cfs @ 12.57 hrs, Volume= 0.311 af, Atten= 0%, Lag= 0.0 min
Primary = 1.98 cfs @ 12.57 hrs, Volume= 0.311 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 50.02' @ 12.57 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	48.30'	**8.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 48.30' / 48.22' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.35 sf

Primary OutFlow Max=1.97 cfs @ 12.57 hrs HW=50.01' TW=47.87' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 1.97 cfs @ 5.65 fps)

Pond SB 01 B: SB 01 B



Summary for Pond SB 01 S: SB 01 S

Inflow Area = 1.049 ac, 2.38% Impervious, Inflow Depth = 3.55" for 25 yr event
Inflow = 1.98 cfs @ 12.57 hrs, Volume= 0.311 af
Outflow = 1.15 cfs @ 13.02 hrs, Volume= 0.311 af, Atten= 42%, Lag= 27.2 min
Primary = 1.15 cfs @ 13.02 hrs, Volume= 0.311 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 48.37' @ 13.02 hrs Surf.Area= 0 sf Storage= 2,253 cf

Plug-Flow detention time= 13.8 min calculated for 0.310 af (100% of inflow)
Center-of-Mass det. time= 13.8 min (853.9 - 840.1)

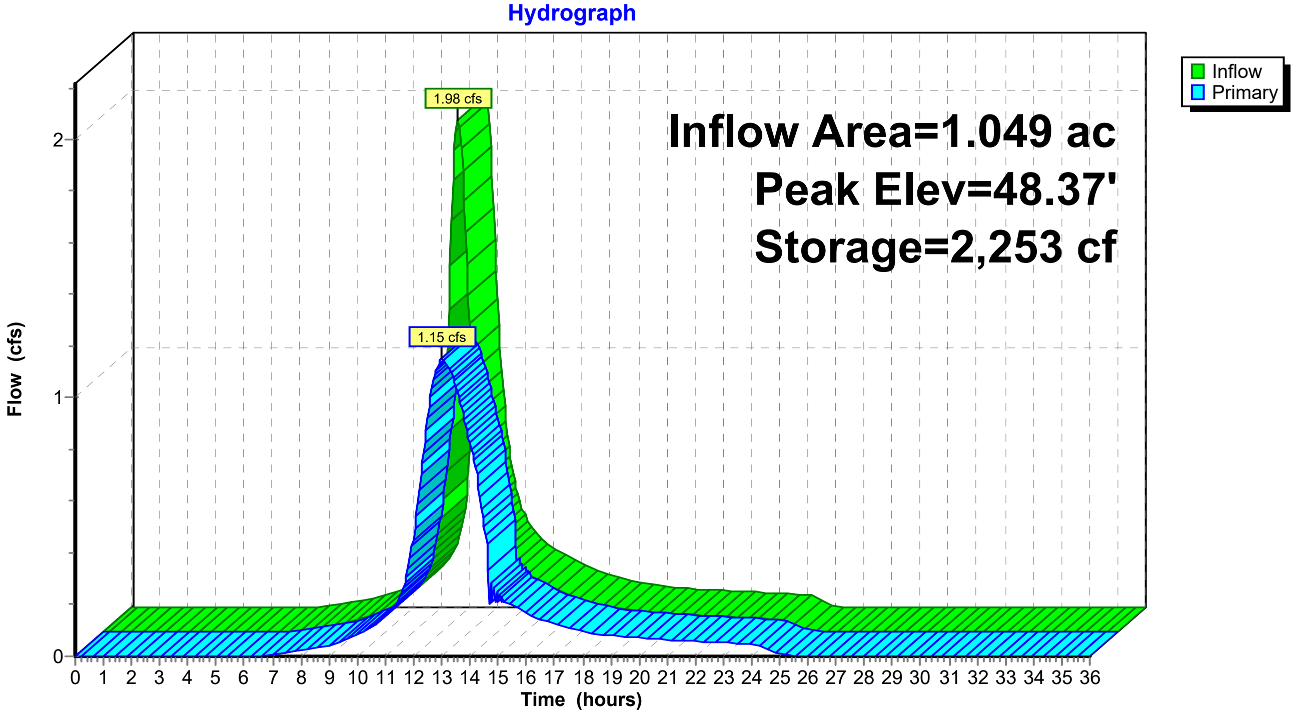
Volume	Invert	Avail.Storage	Storage Description
#1	46.30'	4,121 cf	**Custom Stage Data**Listed below

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
46.30	0	0
46.80	16	16
47.30	386	402
47.80	837	1,239
48.30	886	2,125
48.80	943	3,068
49.30	523	3,591
49.80	530	4,121

Device	Routing	Invert	Outlet Devices
#1	Primary	46.30'	**6.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 46.30' / 46.20' S= 0.0125 '/' Cc= 0.900 n= 0.010, Flow Area= 0.20 sf
#2	Primary	48.30'	**8.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 48.30' / 48.22' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.35 sf

Primary OutFlow Max=1.15 cfs @ 13.02 hrs HW=48.37' TW=46.91' (Dynamic Tailwater)
├─**1=Culvert** (Inlet Controls 1.14 cfs @ 5.80 fps)
└─**2=Culvert** (Barrel Controls 0.02 cfs @ 1.28 fps)

Pond SB 01 S: SB 01 S



Summary for Pond SB 03 B: SB 03B

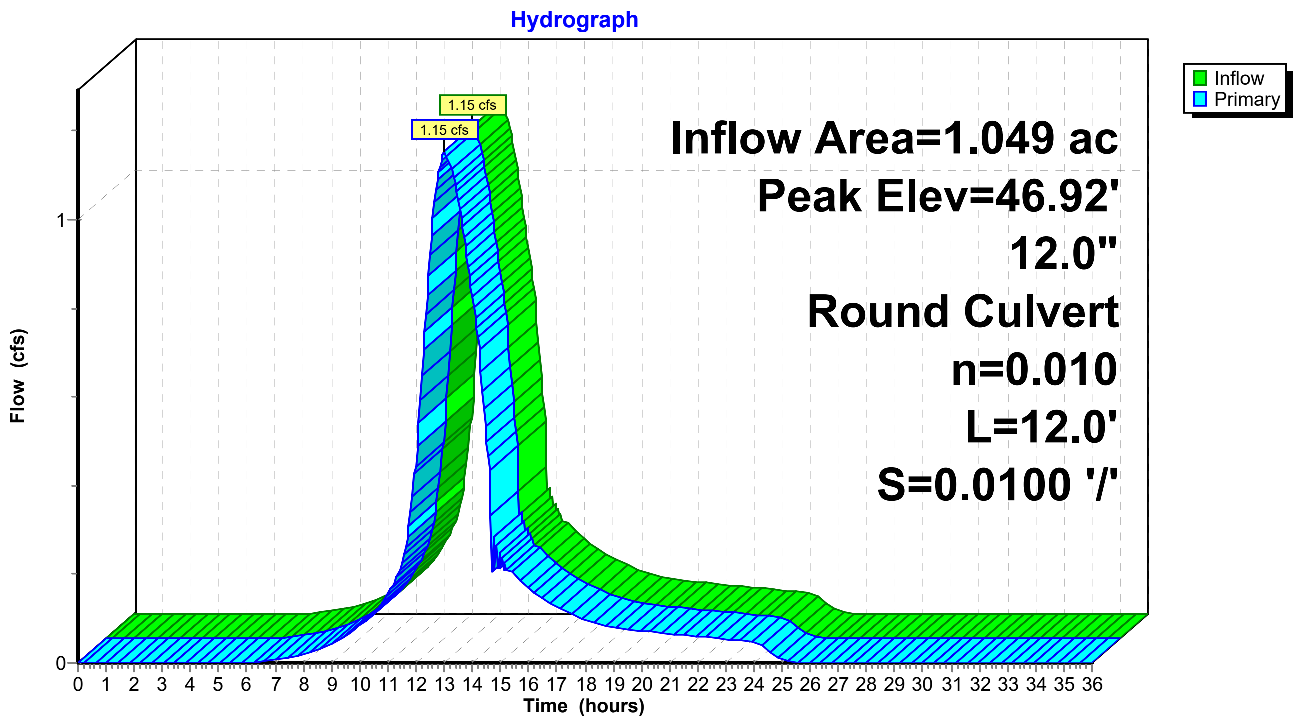
Inflow Area = 1.049 ac, 2.38% Impervious, Inflow Depth = 3.55" for 25 yr event
Inflow = 1.15 cfs @ 13.02 hrs, Volume= 0.311 af
Outflow = 1.15 cfs @ 13.02 hrs, Volume= 0.311 af, Atten= 0%, Lag= 0.0 min
Primary = 1.15 cfs @ 13.02 hrs, Volume= 0.311 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 46.92' @ 12.96 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	46.25'	**12.0" Round Culvert** L= 12.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 46.25' / 46.13' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=1.18 cfs @ 13.02 hrs HW=46.91' TW=46.67' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 1.18 cfs @ 3.02 fps)

Pond SB 03 B: SB 03B



Summary for Pond SB 11 B: SB 11 B

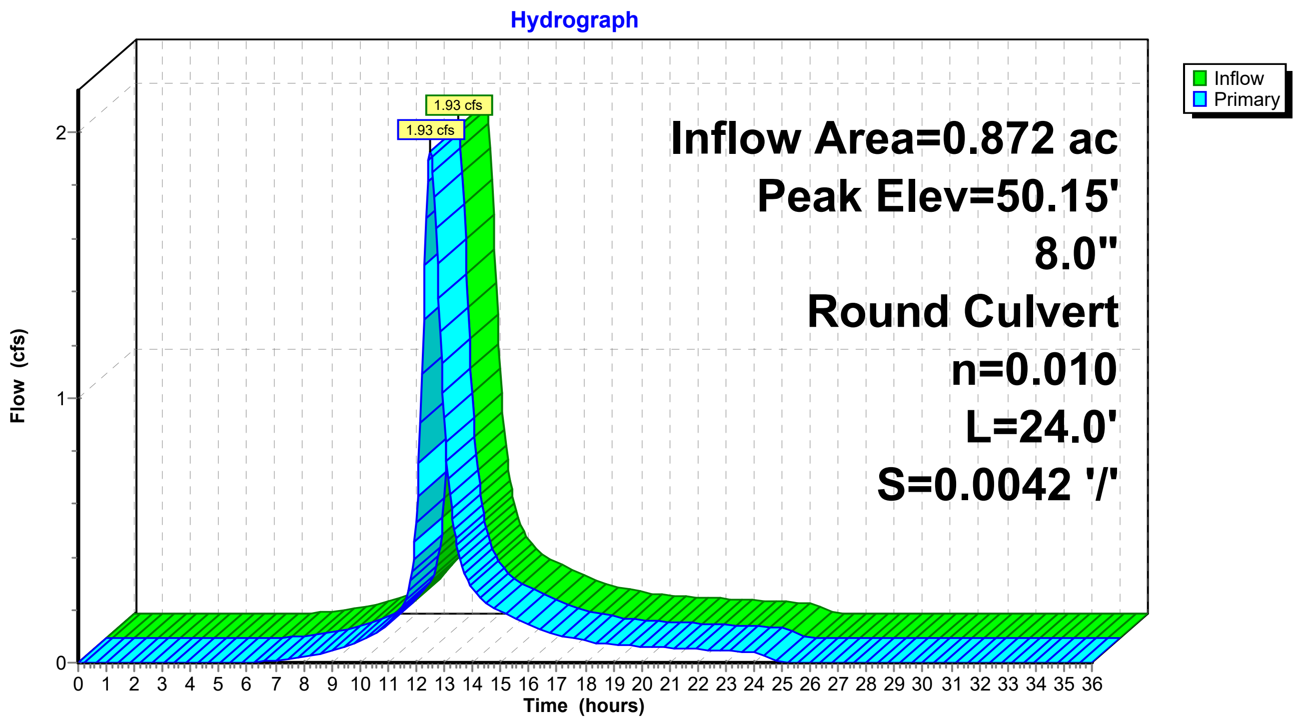
Inflow Area =	0.872 ac,	0.00% Impervious,	Inflow Depth = 3.74"	for 25 yr event
Inflow =	1.93 cfs @	12.51 hrs, Volume=	0.272 af	
Outflow =	1.93 cfs @	12.51 hrs, Volume=	0.272 af,	Atten= 0%, Lag= 0.0 min
Primary =	1.93 cfs @	12.51 hrs, Volume=	0.272 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 50.15' @ 12.51 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	48.50'	**8.0" Round Culvert** L= 24.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 48.50' / 48.40' S= 0.0042 '/' Cc= 0.900 n= 0.010, Flow Area= 0.35 sf

Primary OutFlow Max=1.93 cfs @ 12.51 hrs HW=50.15' TW=48.32' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 1.93 cfs @ 5.52 fps)

Pond SB 11 B: SB 11 B



Summary for Pond SB 11 S: SB 11 S

Inflow Area = 0.872 ac, 0.00% Impervious, Inflow Depth = 3.74" for 25 yr event
Inflow = 1.93 cfs @ 12.51 hrs, Volume= 0.272 af
Outflow = 1.25 cfs @ 12.85 hrs, Volume= 0.272 af, Atten= 35%, Lag= 20.5 min
Primary = 1.25 cfs @ 12.85 hrs, Volume= 0.272 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 48.70' @ 12.85 hrs Surf.Area= 0 sf Storage= 2,656 cf

Plug-Flow detention time= 30.8 min calculated for 0.271 af (100% of inflow)
Center-of-Mass det. time= 30.8 min (864.5 - 833.7)

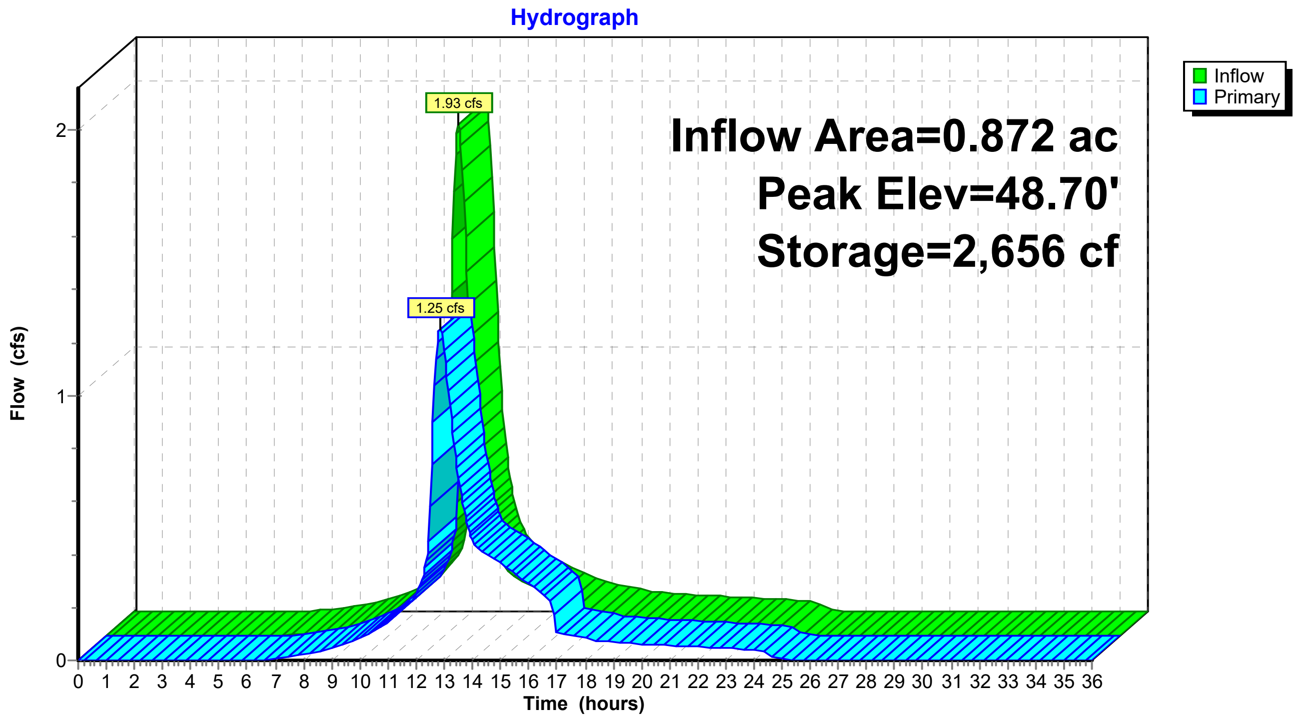
Volume	Invert	Avail.Storage	Storage Description
#1	46.80'	3,953 cf	**Custom Stage Data**Listed below

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
46.80	0	0
47.30	16	16
47.80	888	904
48.30	944	1,848
48.80	1,001	2,849
49.30	544	3,393
49.80	560	3,953

Device	Routing	Invert	Outlet Devices
#1	Primary	46.80'	**4.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 46.80' / 46.72' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.09 sf
#2	Primary	48.10'	**8.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 48.10' / 48.00' S= 0.0125 '/' Cc= 0.900 n= 0.010, Flow Area= 0.35 sf

Primary OutFlow Max=1.25 cfs @ 12.85 hrs HW=48.70' TW=47.45' (Dynamic Tailwater)
├─**1=Culvert** (Inlet Controls 0.47 cfs @ 5.39 fps)
└─**2=Culvert** (Barrel Controls 0.78 cfs @ 3.08 fps)

Pond SB 11 S: SB 11 S



Summary for Pond SB 12 B: SB 12 B

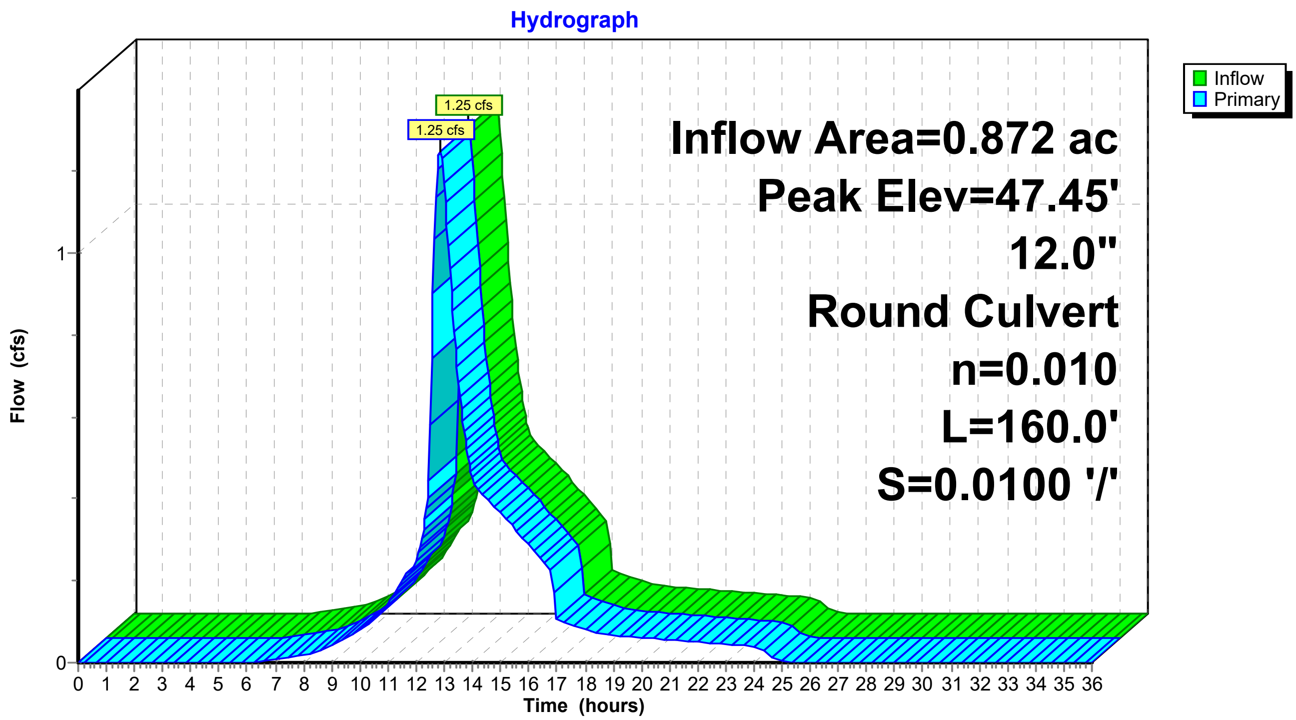
Inflow Area =	0.872 ac,	0.00% Impervious, Inflow Depth =	3.74"	for 25 yr event
Inflow =	1.25 cfs @	12.85 hrs, Volume=	0.272 af	
Outflow =	1.25 cfs @	12.85 hrs, Volume=	0.272 af, Atten= 0%, Lag= 0.0 min	
Primary =	1.25 cfs @	12.85 hrs, Volume=	0.272 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 47.45' @ 12.86 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	46.80'	**12.0" Round Culvert** L= 160.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 46.80' / 45.20' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=1.24 cfs @ 12.85 hrs HW=47.45' TW=46.69' (Dynamic Tailwater)
1=Culvert (Outlet Controls 1.24 cfs @ 3.28 fps)

Pond SB 12 B: SB 12 B

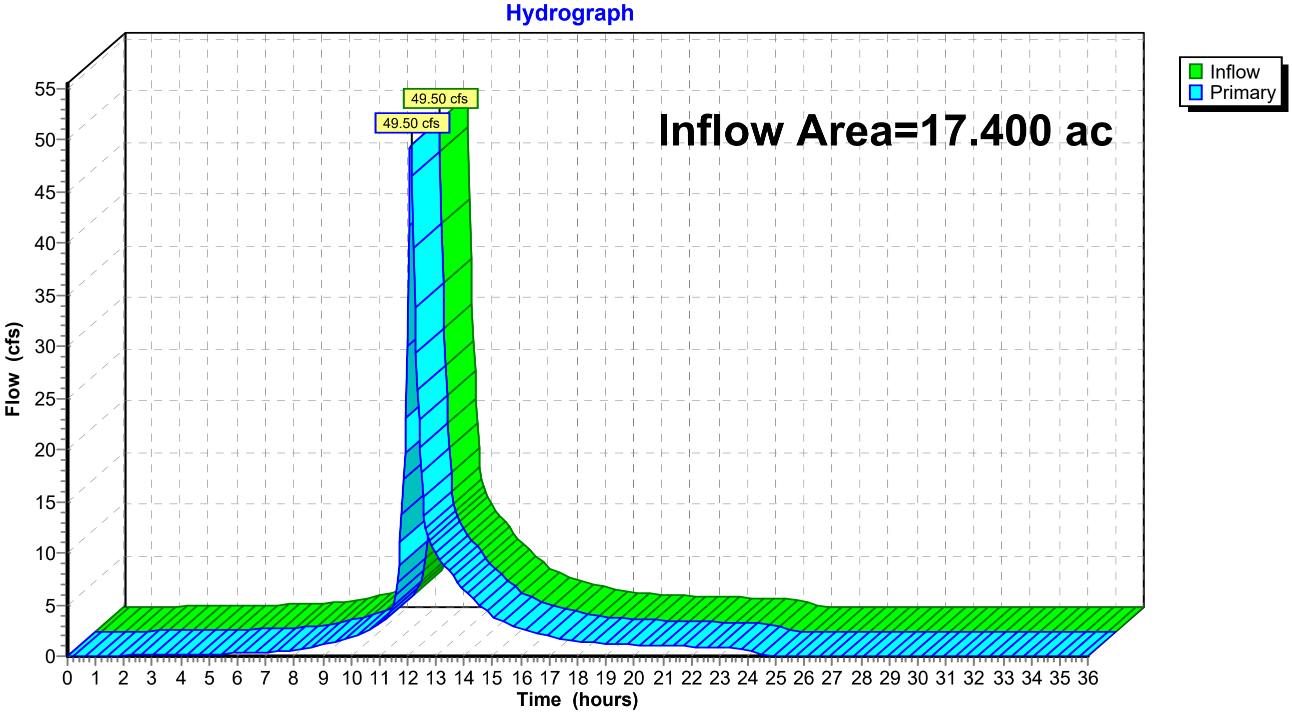


Summary for Link POA: POA

Inflow Area =	17.400 ac, 49.60% Impervious, Inflow Depth > 3.67"	for 25 yr event	
Inflow =	49.50 cfs @ 12.11 hrs, Volume=	5.318 af	
Primary =	49.50 cfs @ 12.11 hrs, Volume=	5.318 af, Atten= 0%, Lag= 0.0 min	

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Link POA: POA



Summary for Subcatchment PR-1: PR-1

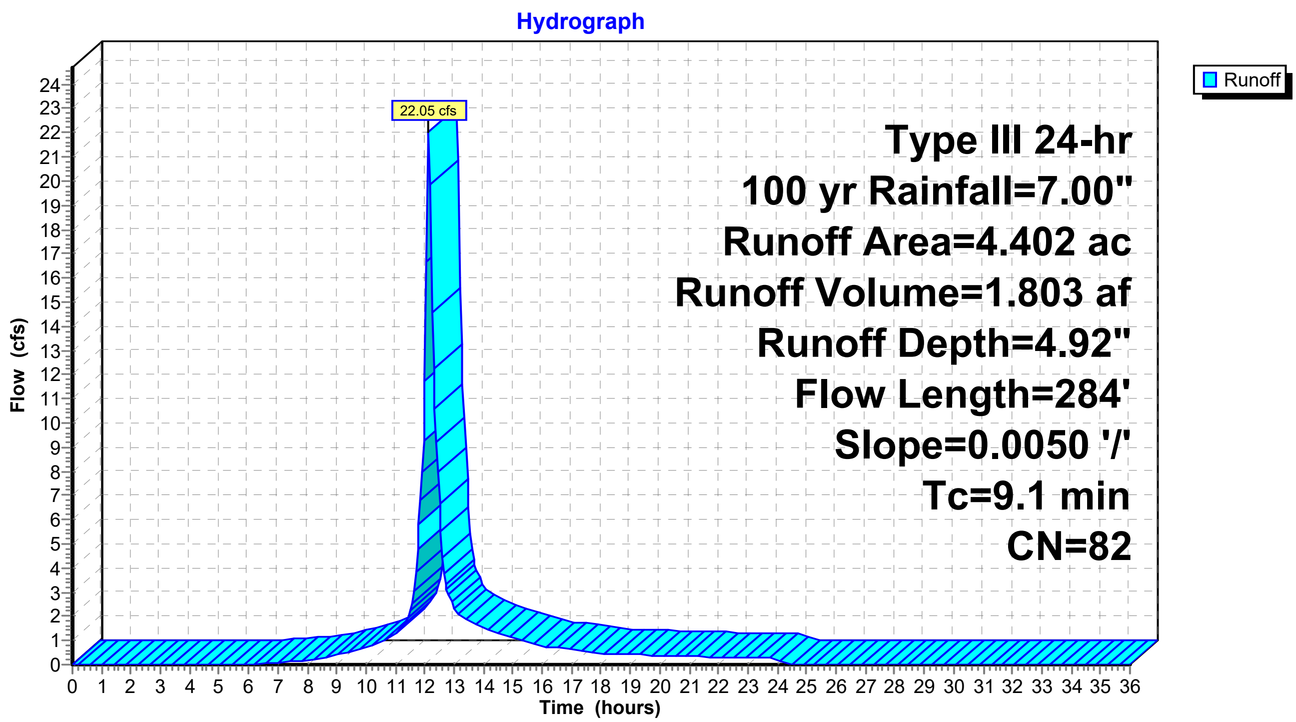
Runoff = 22.05 cfs @ 12.13 hrs, Volume= 1.803 af, Depth= 4.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=7.00"

Area (ac)	CN	Description
1.892	61	>75% Grass cover, Good, HSG B
2.510	98	Paved parking, HSG B
4.402	82	Weighted Average
1.892		42.98% Pervious Area
2.510		57.02% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	50	0.0050	0.69		**Sheet Flow, A-B** Smooth surfaces n= 0.011 P2= 3.20"
7.9	234	0.0050	0.49		**Shallow Concentrated Flow, B-C** Short Grass Pasture Kv= 7.0 fps
9.1	284	Total			

Subcatchment PR-1: PR-1



Summary for Subcatchment PR-1A: PR-1A

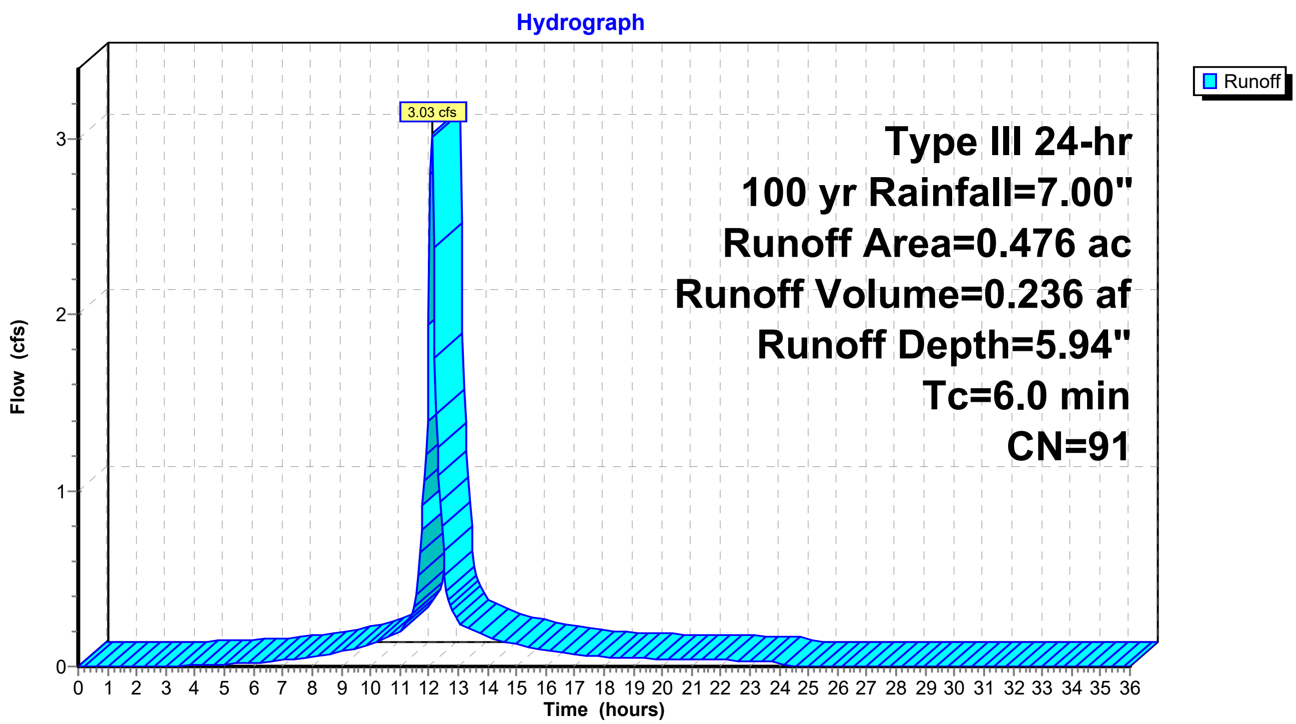
Runoff = 3.03 cfs @ 12.09 hrs, Volume= 0.236 af, Depth= 5.94"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=7.00"

Area (ac)	CN	Description
0.090	61	>75% Grass cover, Good, HSG B
0.386	98	Paved parking, HSG B
0.476	91	Weighted Average
0.090		18.91% Pervious Area
0.386		81.09% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-1A: PR-1A



Summary for Subcatchment PR-1B: PR-1B

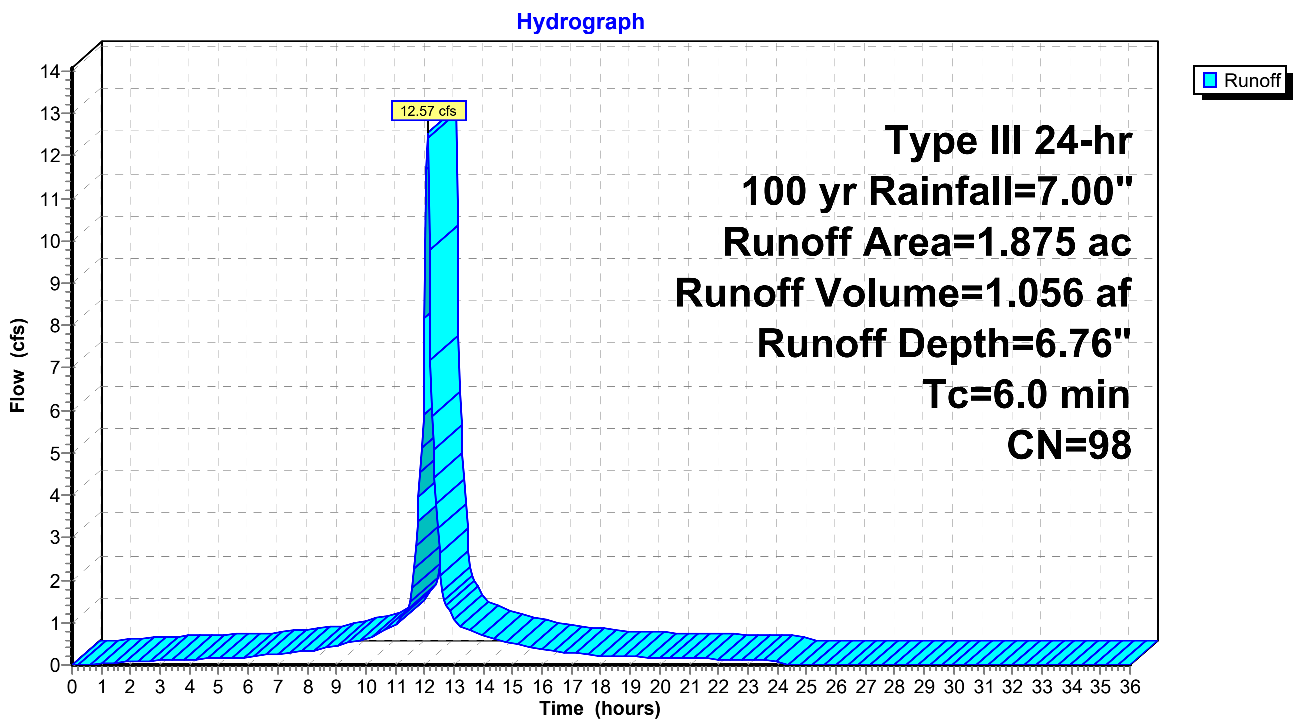
Runoff = 12.57 cfs @ 12.09 hrs, Volume= 1.056 af, Depth= 6.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=7.00"

Area (ac)	CN	Description
1.875	98	Roofs, HSG B
1.875		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-1B: PR-1B



Summary for Subcatchment PR-1C: PR-1C

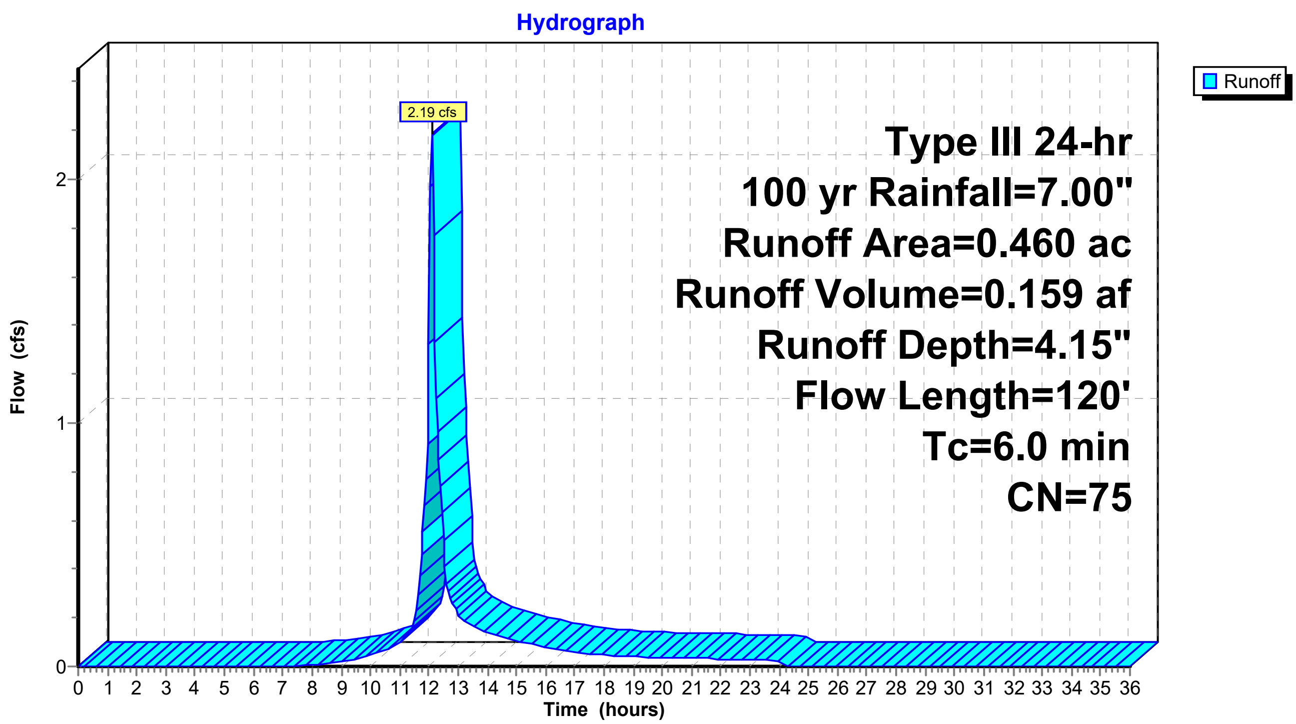
Runoff = 2.19 cfs @ 12.09 hrs, Volume= 0.159 af, Depth= 4.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=7.00"

Area (ac)	CN	Description
0.020	55	Woods, Good, HSG B
0.260	61	>75% Grass cover, Good, HSG B
0.180	98	Paved parking, HSG B
0.460	75	Weighted Average
0.280		60.87% Pervious Area
0.180		39.13% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	20	0.0700	0.09		**Sheet Flow, 20' SF** Woods: Light underbrush n= 0.400 P2= 3.20"
1.9	40	0.5000	0.35		**Sheet Flow, 30' SF** Grass: Dense n= 0.240 P2= 3.20"
0.1	12	0.0100	1.61		**Shallow Concentrated Flow, 12' SCF** Unpaved Kv= 16.1 fps
0.2	48	0.0400	4.06		**Shallow Concentrated Flow, 48' SCF** Paved Kv= 20.3 fps
5.8	120	Total, Increased to minimum Tc = 6.0 min			

Subcatchment PR-1C: PR-1C



Summary for Subcatchment PR-1D: PR-1D

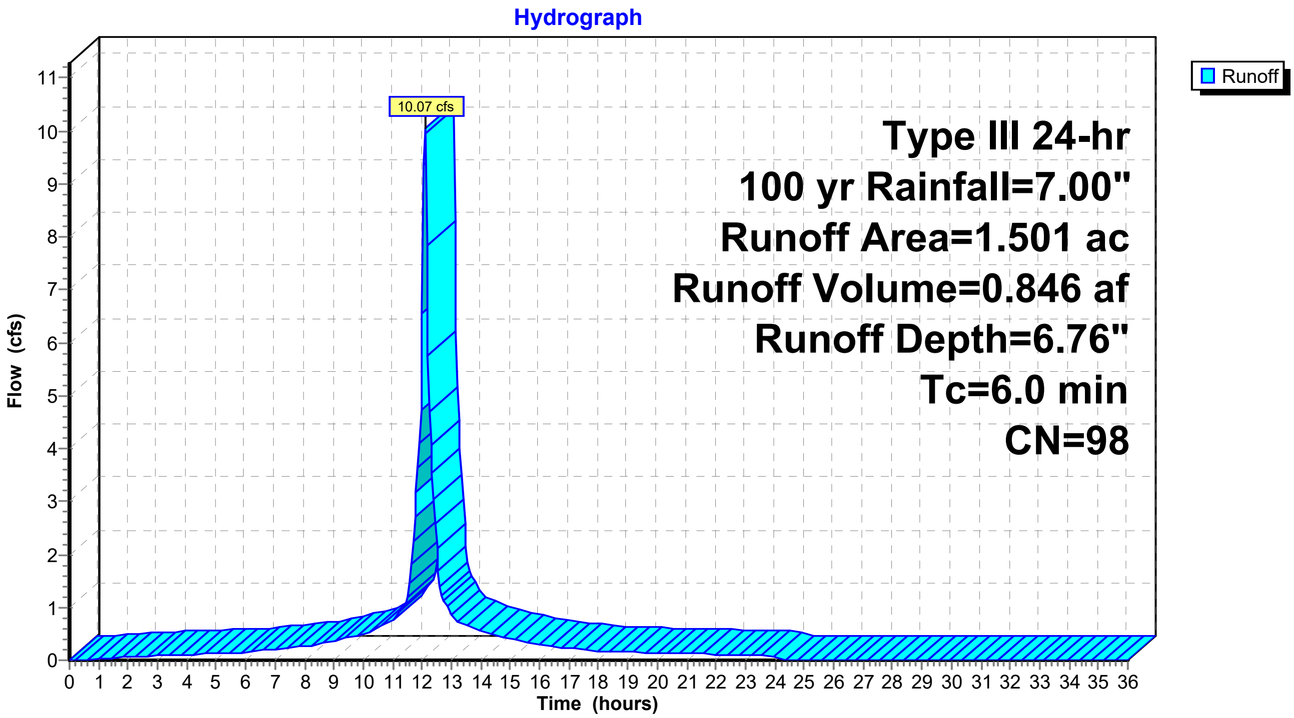
Runoff = 10.07 cfs @ 12.09 hrs, Volume= 0.846 af, Depth= 6.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=7.00"

Area (ac)	CN	Description
1.501	98	Roofs, HSG B
1.501		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-1D: PR-1D



Summary for Subcatchment PR-1E: PR-1E

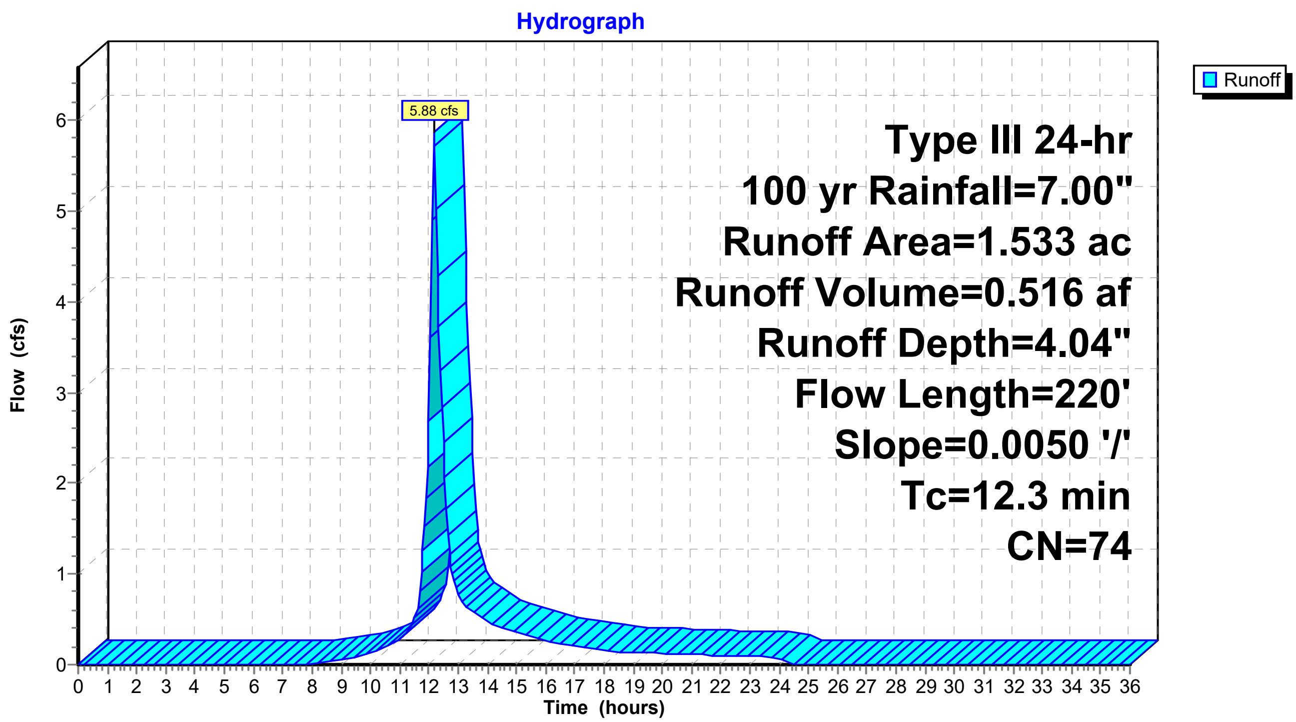
Runoff = 5.88 cfs @ 12.17 hrs, Volume= 0.516 af, Depth= 4.04"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=7.00"

Area (ac)	CN	Description
1.000	61	>75% Grass cover, Good, HSG B
0.533	98	Paved parking, HSG B
1.533	74	Weighted Average
1.000		65.23% Pervious Area
0.533		34.77% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.8	50	0.0050	0.09		**Sheet Flow, 50' SF** Grass: Short n= 0.150 P2= 3.20"
2.5	170	0.0050	1.14		**Shallow Concentrated Flow, 170' SCF** Unpaved Kv= 16.1 fps
12.3	220	Total			

Subcatchment PR-1E: PR-1E



Summary for Subcatchment PR-2: PR-2

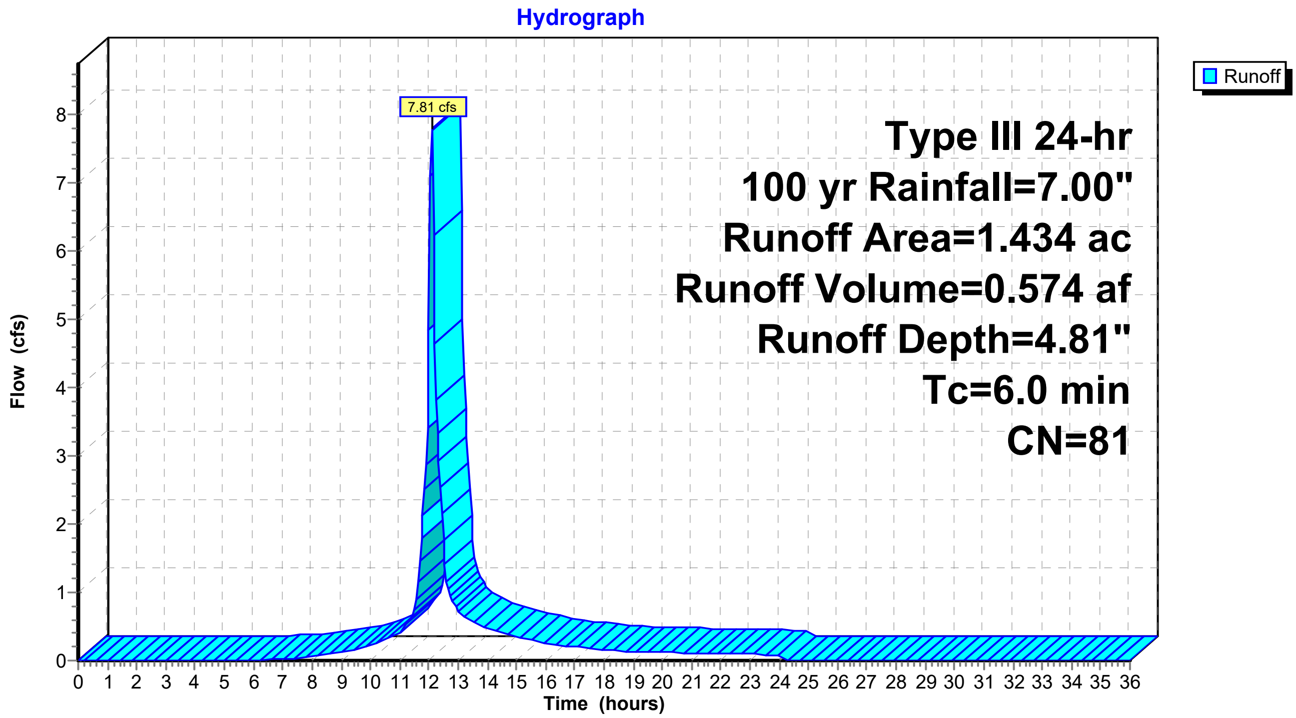
Runoff = 7.81 cfs @ 12.09 hrs, Volume= 0.574 af, Depth= 4.81"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=7.00"

Area (ac)	CN	Description
0.672	61	>75% Grass cover, Good, HSG B
0.762	98	Paved parking, HSG B
1.434	81	Weighted Average
0.672		46.86% Pervious Area
0.762		53.14% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-2: PR-2



Summary for Subcatchment PR-2A: PR-2B

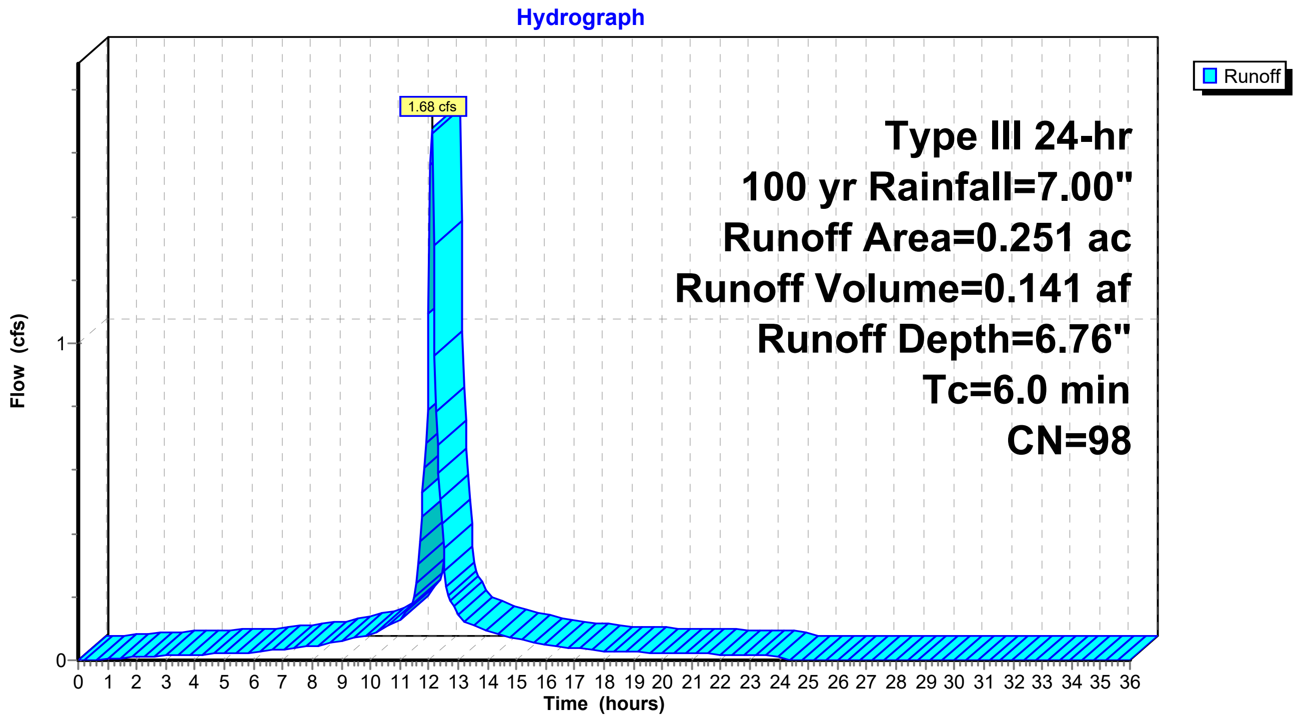
Runoff = 1.68 cfs @ 12.09 hrs, Volume= 0.141 af, Depth= 6.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=7.00"

Area (ac)	CN	Description
0.251	98	Roofs, HSG B
0.251		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-2A: PR-2B



Summary for Subcatchment PR-3A: PR-3A

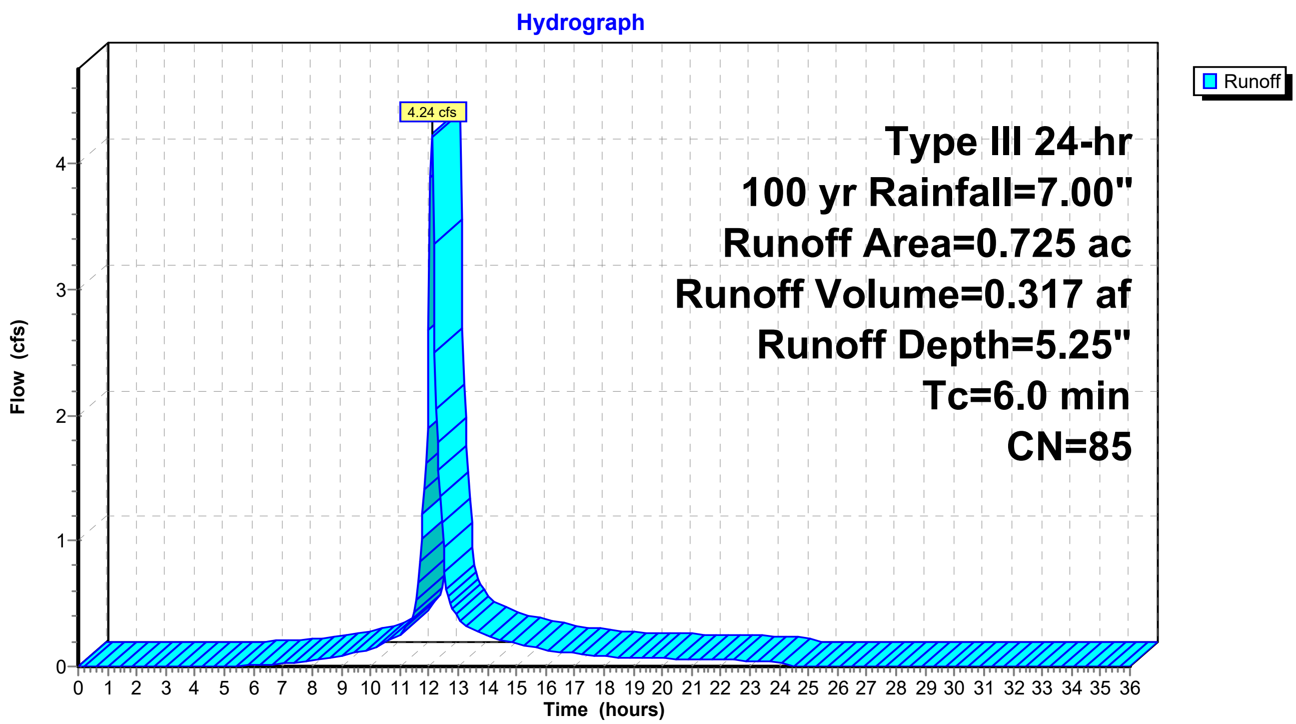
Runoff = 4.24 cfs @ 12.09 hrs, Volume= 0.317 af, Depth= 5.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=7.00"

Area (ac)	CN	Description
0.249	61	>75% Grass cover, Good, HSG B
0.476	98	Paved parking, HSG B
0.725	85	Weighted Average
0.249		34.34% Pervious Area
0.476		65.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-3A: PR-3A



Summary for Subcatchment PR-3B: PR-3B

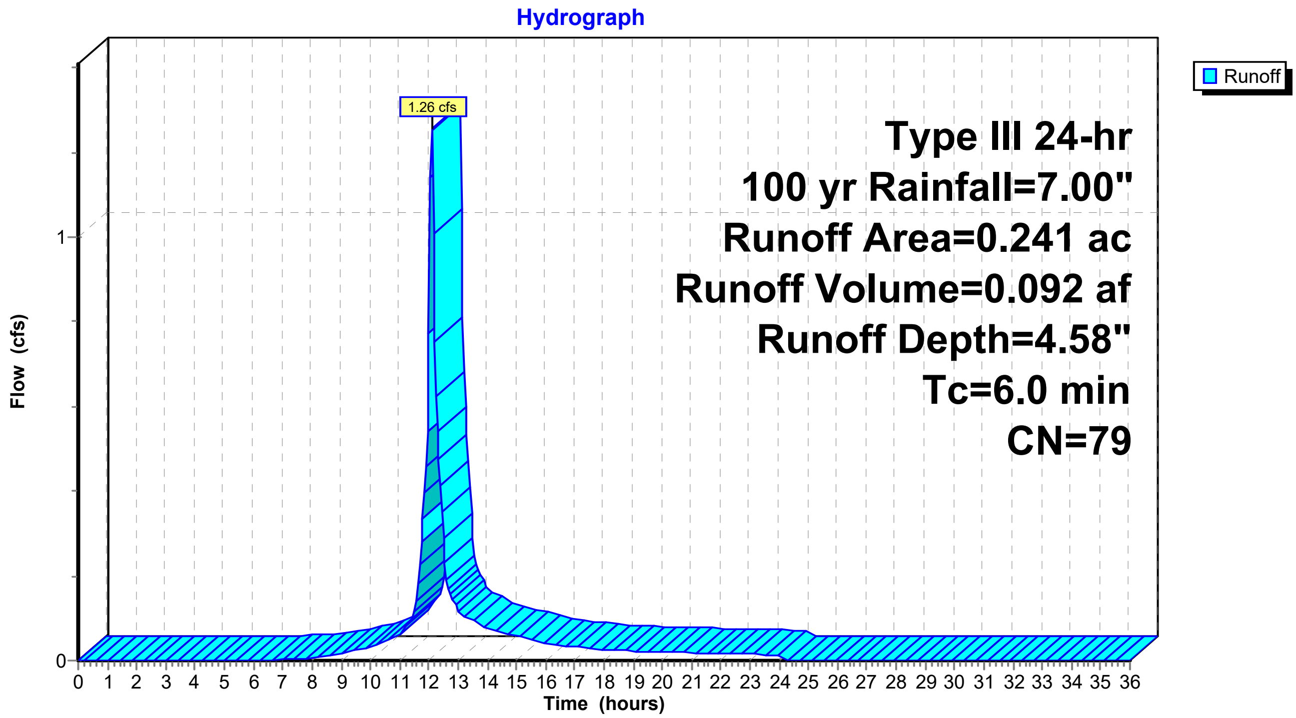
Runoff = 1.26 cfs @ 12.09 hrs, Volume= 0.092 af, Depth= 4.58"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=7.00"

Area (ac)	CN	Description
0.124	61	>75% Grass cover, Good, HSG B
0.117	98	Paved parking, HSG B
0.241	79	Weighted Average
0.124		51.45% Pervious Area
0.117		48.55% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-3B: PR-3B



Summary for Subcatchment PR-3C: PR-3C

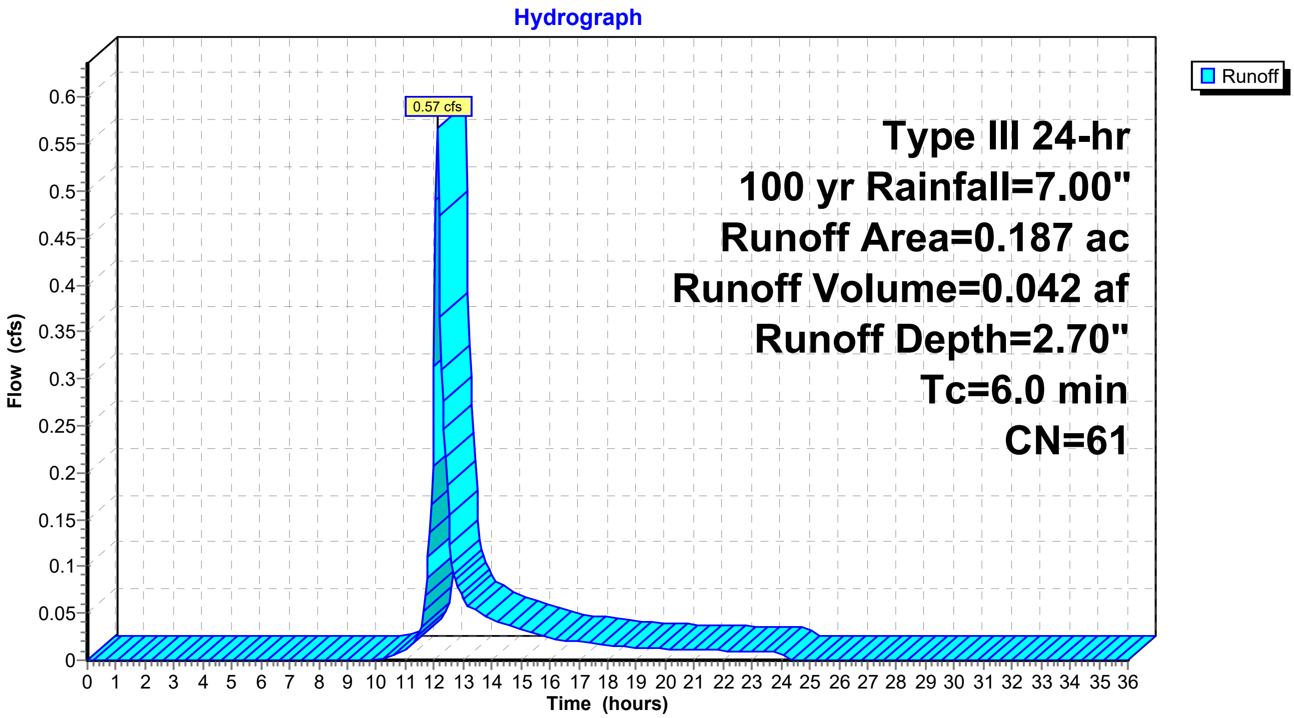
Runoff = 0.57 cfs @ 12.10 hrs, Volume= 0.042 af, Depth= 2.70"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=7.00"

Area (ac)	CN	Description
0.187	61	>75% Grass cover, Good, HSG B
0.187		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-3C: PR-3C



Summary for Subcatchment PR-4A: PR-5A

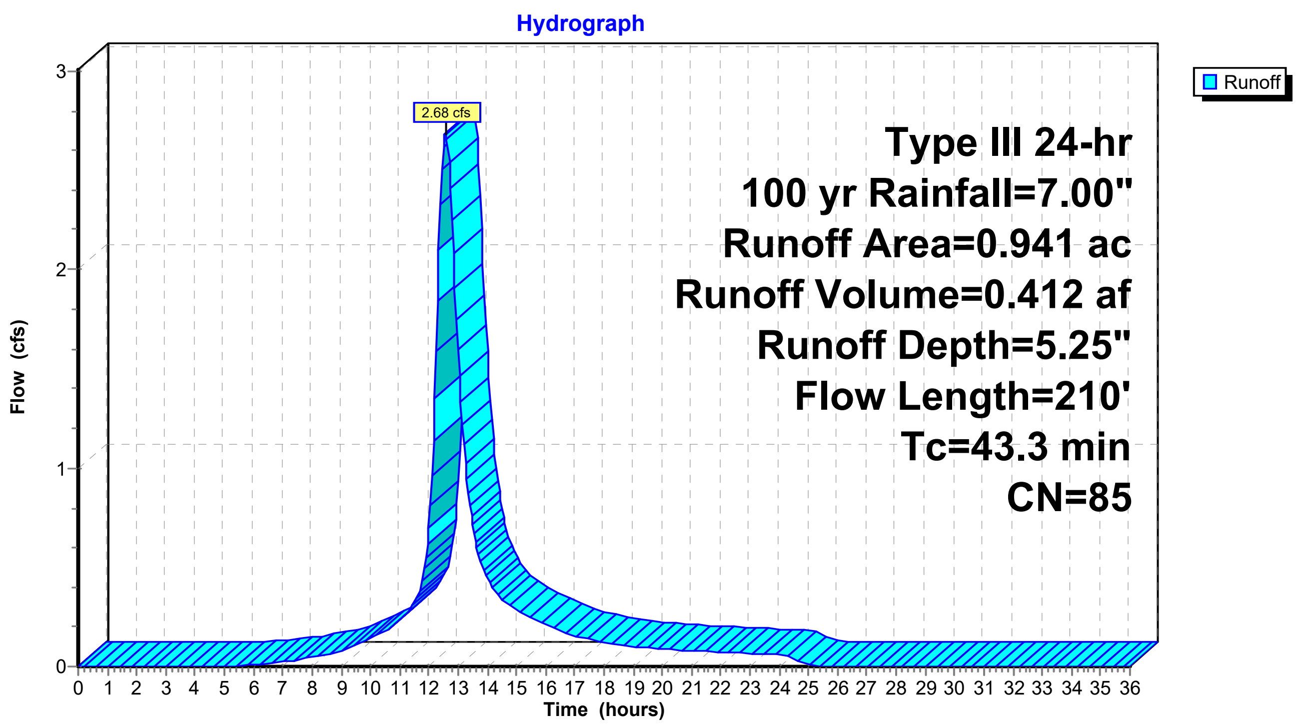
Runoff = 2.68 cfs @ 12.57 hrs, Volume= 0.412 af, Depth= 5.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=7.00"

	Area (ac)	CN	Description
*	0.941	85	SYNTHETIC TURF- PAD- LINER
	0.941		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
39.6	110	0.0055	0.05		**Sheet Flow, Through Turf Section** Grass: Bermuda n= 0.410 P2= 3.20"
3.7	100	0.0001	0.45	0.16	**Pipe Channel, TRENCH DRAIN LEVEL** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010
43.3	210	Total			

Subcatchment PR-4A: PR-5A



Summary for Subcatchment PR-4B: SB 11 A

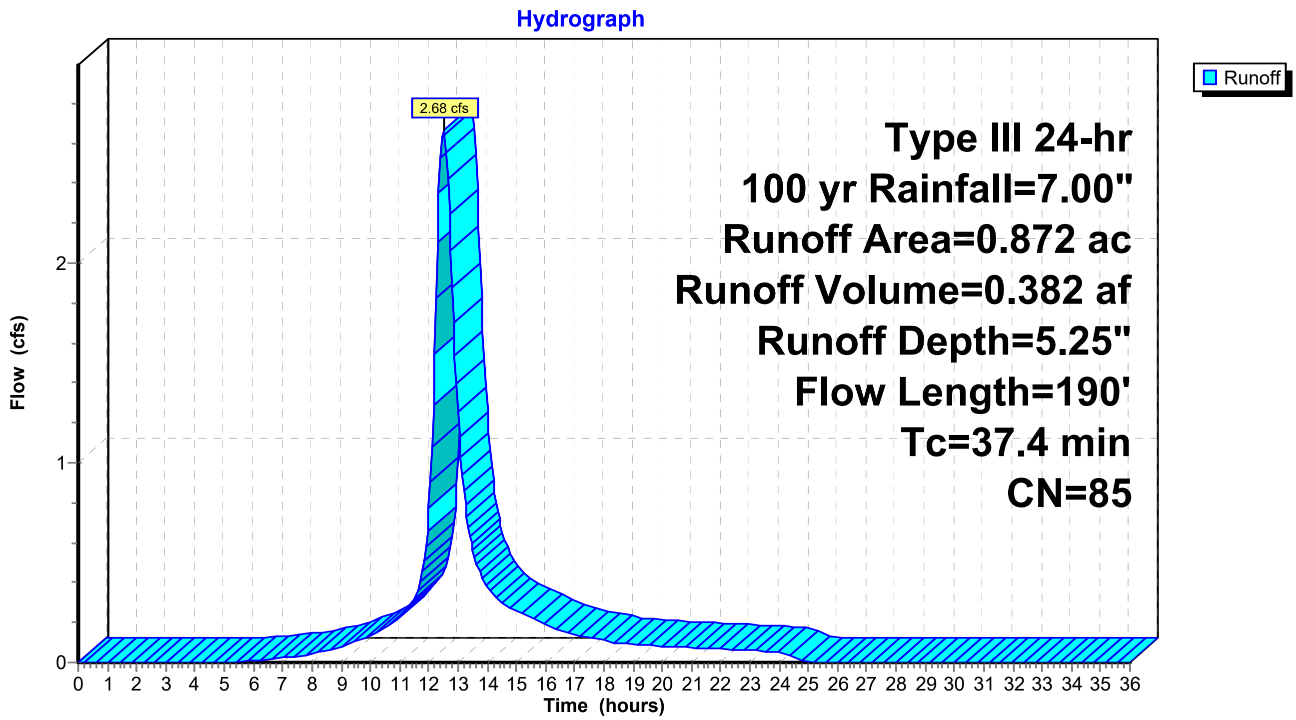
Runoff = 2.68 cfs @ 12.50 hrs, Volume= 0.382 af, Depth= 5.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=7.00"

	Area (ac)	CN	Description
*	0.872	85	SYNTHETIC TURF- PAD- LINER
	0.872		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
33.7	90	0.0055	0.04		**Sheet Flow, Through Turf Section** Grass: Bermuda n= 0.410 P2= 3.20"
3.7	100	0.0001	0.45	0.16	**Pipe Channel, TRENCH DRAIN LEVEL** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010
37.4	190	Total			

Subcatchment PR-4B: SB 11 A



Summary for Subcatchment PR-4C: SB 00 DPW SLOPE

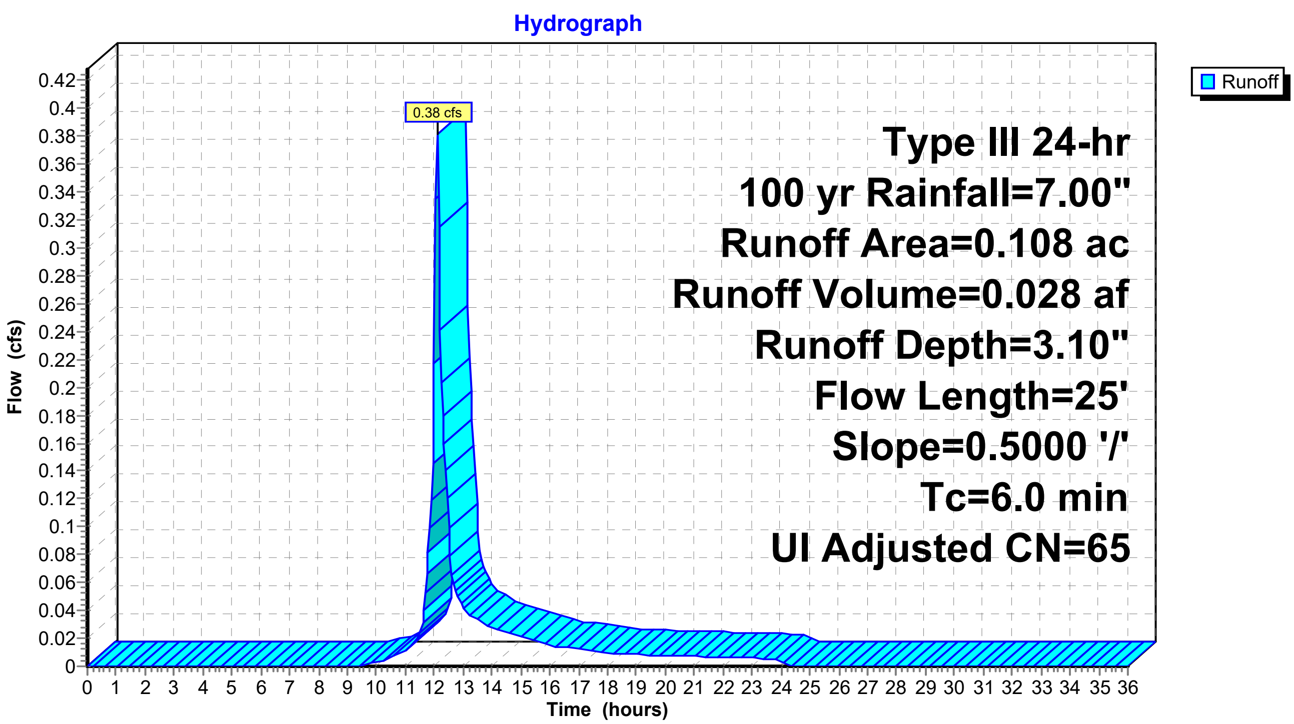
Runoff = 0.38 cfs @ 12.10 hrs, Volume= 0.028 af, Depth= 3.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=7.00"

Area (ac)	CN	Adj	Description
0.025	98		Unconnected pavement, HSG B
0.083	61		>75% Grass cover, Good, HSG B
0.108	70	65	Weighted Average, UI Adjusted
0.083			76.85% Pervious Area
0.025			23.15% Impervious Area
0.025			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.3	25	0.5000	0.32		**Sheet Flow, SLOPING LAND** Grass: Dense n= 0.240 P2= 3.20"
1.3	25	Total, Increased to minimum Tc = 6.0 min			

Subcatchment PR-4C: SB 00 DPW SLOPE



Summary for Subcatchment PR-5A: BB 01 A

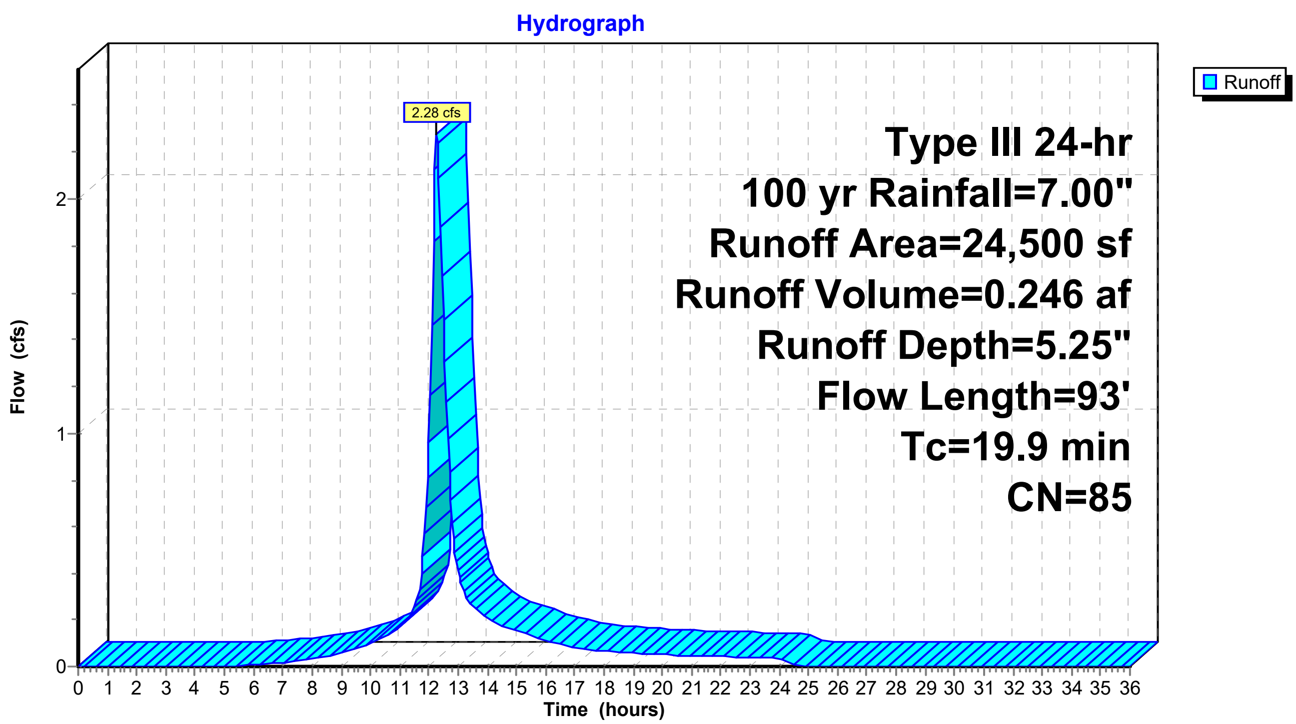
Runoff = 2.28 cfs @ 12.27 hrs, Volume= 0.246 af, Depth= 5.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=7.00"

	Area (sf)	CN	Description
*	24,500	85	SYNTHETIC TURF- PAD- LINER
	24,500		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.2	46	0.0067	0.04		**Sheet Flow, Through Turf Section** Grass: Bermuda n= 0.410 P2= 3.20"
1.7	47	0.0001	0.45	0.16	**Pipe Channel, TRENCH DRAIN LEVEL** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010
19.9	93	Total			

Subcatchment PR-5A: BB 01 A



Summary for Subcatchment PR-5B: BB 11 A

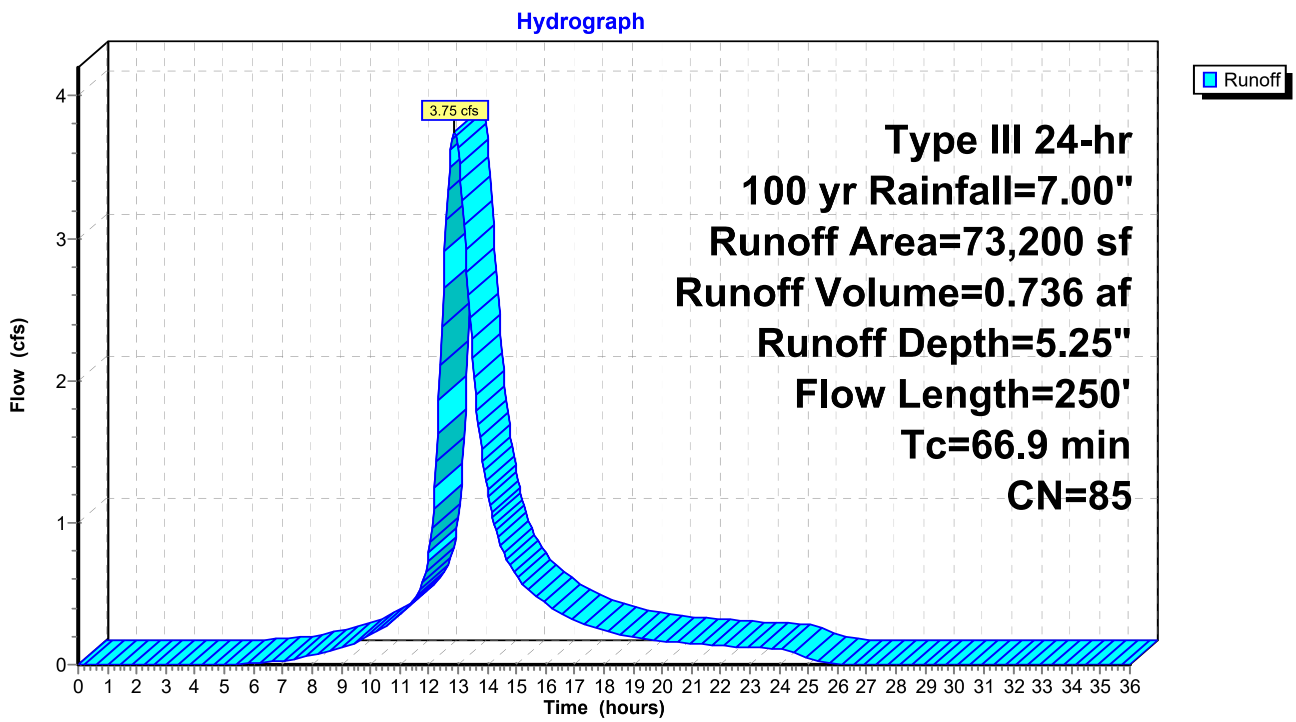
Runoff = 3.75 cfs @ 12.87 hrs, Volume= 0.736 af, Depth= 5.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=7.00"

	Area (sf)	CN	Description
*	73,200	85	SYNTHETIC TURF- PAD- LINER
	73,200		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.1	53	0.0055	0.04		**Sheet Flow, Through Turf Section** Grass: Bermuda n= 0.410 P2= 3.20"
43.1	150	0.0083	0.06		**Sheet Flow, SYNTHETIC TURF** Grass: Bermuda n= 0.410 P2= 3.20"
1.7	47	0.0001	0.45	0.16	**Pipe Channel, TRENCH DRAIN LEVEL** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010
66.9	250	Total			

Subcatchment PR-5B: BB 11 A



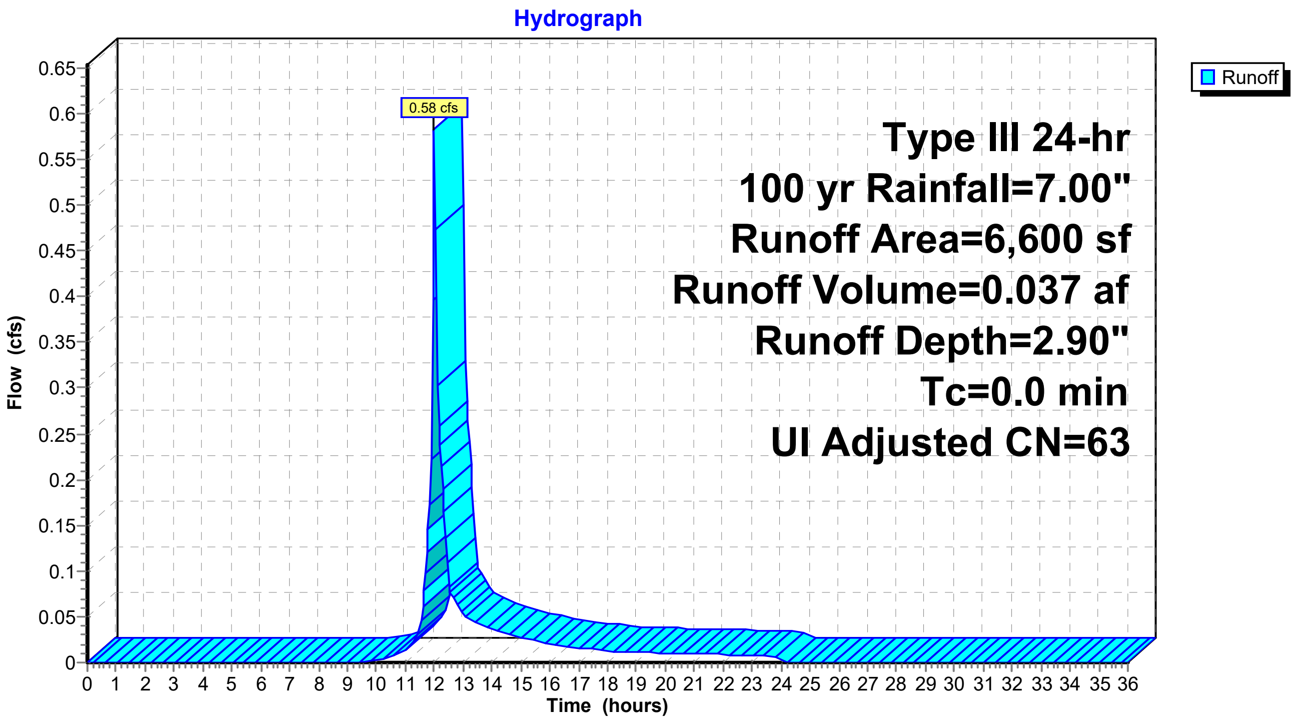
Summary for Subcatchment PR-5C: SLOPE

Runoff = 0.58 cfs @ 12.01 hrs, Volume= 0.037 af, Depth= 2.90"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=7.00"

Area (sf)	CN	Adj	Description
600	98		Unconnected roofs, HSG B
6,000	61		>75% Grass cover, Good, HSG B
6,600	64	63	Weighted Average, UI Adjusted
6,000			90.91% Pervious Area
600			9.09% Impervious Area
600			100.00% Unconnected

Subcatchment PR-5C: SLOPE



Summary for Pond 1P: rain garden#1 cascading

Inflow Area = 0.725 ac, 65.66% Impervious, Inflow Depth = 5.25" for 100 yr event
Inflow = 4.24 cfs @ 12.09 hrs, Volume= 0.317 af
Outflow = 4.50 cfs @ 12.10 hrs, Volume= 0.315 af, Atten= 0%, Lag= 0.7 min
Primary = 2.91 cfs @ 12.10 hrs, Volume= 0.304 af
Secondary = 1.59 cfs @ 12.10 hrs, Volume= 0.011 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 62.09' @ 12.10 hrs Surf.Area= 517 sf Storage= 596 cf
Flood Elev= 63.00' Surf.Area= 660 sf Storage= 1,132 cf

Plug-Flow detention time= 31.1 min calculated for 0.315 af (99% of inflow)
Center-of-Mass det. time= 27.2 min (822.2 - 795.1)

Volume	Invert	Avail.Storage	Storage Description
#1	58.50'	1,048 cf	**Rain Garden Envelope (Prismatic)** Listed below (Recalc) 1,348 cf Overall - 300 cf Embedded = 1,048 cf
#2	58.50'	30 cf	**crush stone (Prismatic)** Listed below (Recalc) Inside #1 75 cf Overall x 40.0% Voids
#3	59.00'	50 cf	**Bio Media (Prismatic)** Listed below (Recalc) Inside #1 199 cf Overall x 25.0% Voids
#4	60.33'	5 cf	**Mulch (Prismatic)** Listed below (Recalc) Inside #1 26 cf Overall x 20.0% Voids
		1,132 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
58.50	150	0	0
60.50	150	300	300
61.00	236	97	397
62.00	503	370	766
63.00	660	582	1,348

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
58.50	150	0	0
59.00	150	75	75

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
59.00	150	0	0
60.33	150	199	199

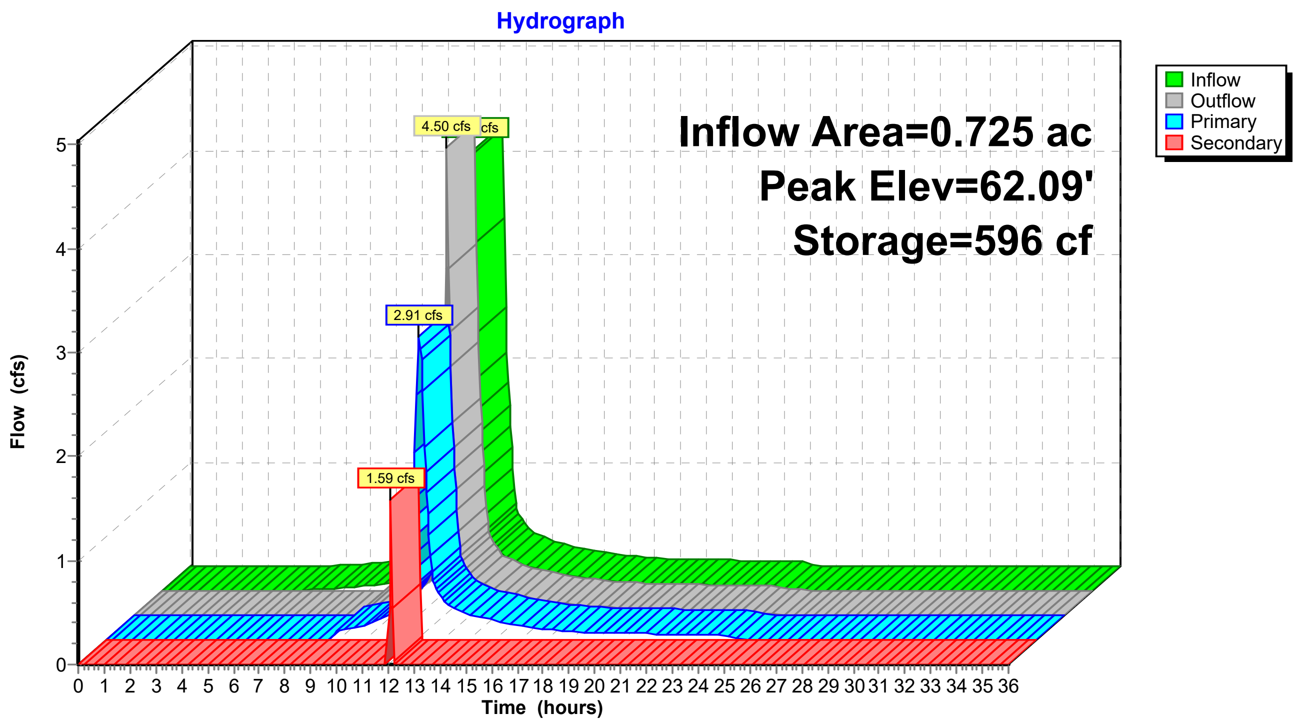
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
60.33	150	0	0
60.50	150	26	26

Device	Routing	Invert	Outlet Devices
#1	Device 3	58.50'	**1.020 in/hr Exfiltration over Surface area**
#2	Secondary	62.00'	**25.0' long x 3.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32
#3	Primary	58.50'	**8.0" Round Culvert** L= 20.0' Ke= 0.500 Inlet / Outlet Invert= 58.50' / 58.40' S= 0.0050 '/' Cc= 0.900 n= 0.012, Flow Area= 0.35 sf
#4	Device 3	61.50'	**12.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=2.91 cfs @ 12.10 hrs HW=62.09' TW=54.59' (Dynamic Tailwater)
└─**3=Culvert** (Passes 2.91 cfs of 3.03 cfs potential flow)
  ├─**1=Exfiltration** (Exfiltration Controls 0.01 cfs)
  └─**4=Orifice/Grate** (Orifice Controls 2.90 cfs @ 3.69 fps)

Secondary OutFlow Max=1.59 cfs @ 12.10 hrs HW=62.09' TW=54.59' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir** (Weir Controls 1.59 cfs @ 0.72 fps)

Pond 1P: rain garden#1 cascading



Summary for Pond 2P: rain garden#2 cascading

Inflow Area = 0.966 ac, 61.39% Impervious, Inflow Depth > 5.06" for 100 yr event
Inflow = 5.76 cfs @ 12.10 hrs, Volume= 0.407 af
Outflow = 5.30 cfs @ 12.12 hrs, Volume= 0.400 af, Atten= 8%, Lag= 1.5 min
Primary = 3.54 cfs @ 12.12 hrs, Volume= 0.387 af
Secondary = 1.77 cfs @ 12.12 hrs, Volume= 0.014 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 54.61' @ 12.12 hrs Surf.Area= 1,080 sf Storage= 1,315 cf
Flood Elev= 55.00' Surf.Area= 1,326 sf Storage= 1,784 cf

Plug-Flow detention time= 44.3 min calculated for 0.400 af (98% of inflow)
Center-of-Mass det. time= 28.7 min (848.2 - 819.6)

Volume	Invert	Avail.Storage	Storage Description
#1	51.00'	1,557 cf	**Rain Garden Envelope (Prismatic)**Listed below (Recalc) 2,357 cf Overall - 800 cf Embedded = 1,557 cf
#2	51.00'	80 cf	**crush stone (Prismatic)**Listed below (Recalc) Inside #1 200 cf Overall x 40.0% Voids
#3	51.50'	133 cf	**Bio Media (Prismatic)**Listed below (Recalc) Inside #1 532 cf Overall x 25.0% Voids
#4	52.83'	14 cf	**Mulch (Prismatic)**Listed below (Recalc) Inside #1 68 cf Overall x 20.0% Voids
		1,784 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
51.00	400	0	0
53.00	400	800	800
54.00	694	547	1,347
55.00	1,326	1,010	2,357

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
51.00	400	0	0
51.50	400	200	200

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
51.50	400	0	0
52.83	400	532	532

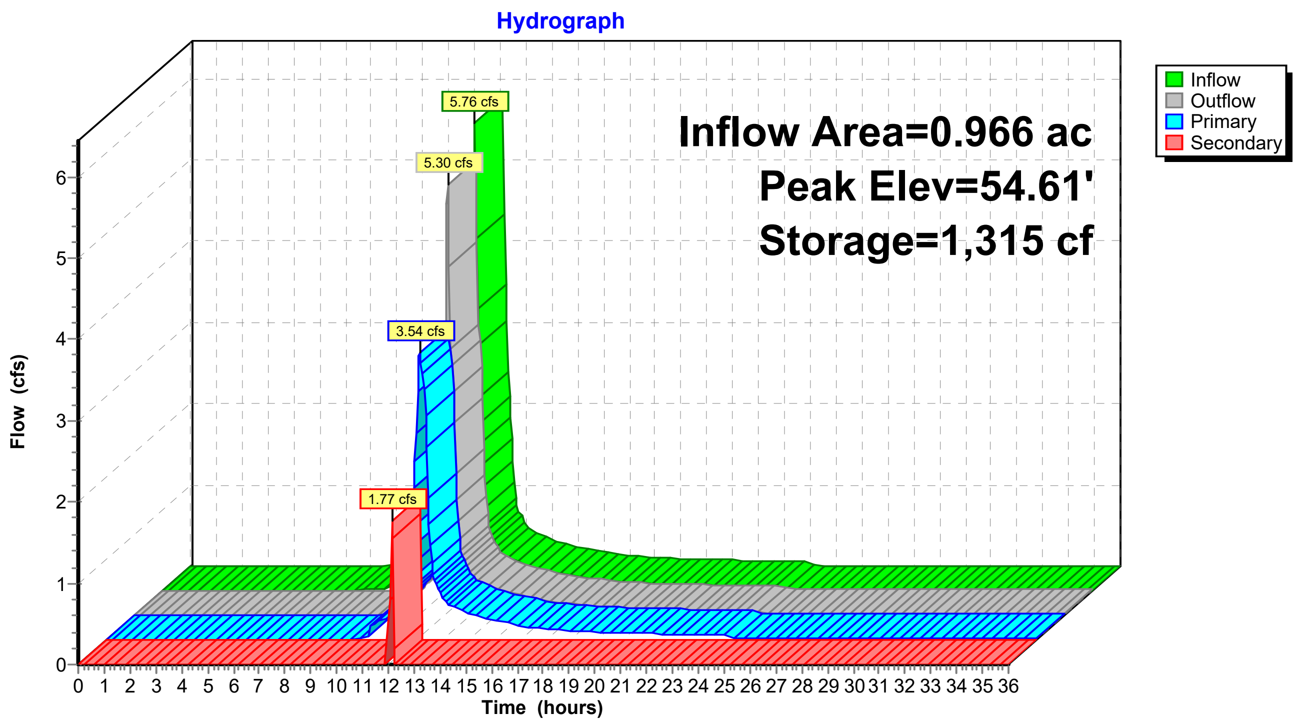
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
52.83	400	0	0
53.00	400	68	68

Device	Routing	Invert	Outlet Devices
#1	Device 3	51.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Secondary	54.50'	**25.0' long x 3.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32
#3	Primary	51.00'	**12.0" Round Culvert** L= 25.0' Ke= 0.500 Inlet / Outlet Invert= 51.00' / 50.88' S= 0.0048 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf
#4	Device 3	53.75'	**12.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=3.49 cfs @ 12.12 hrs HW=54.59' TW=49.02' (Dynamic Tailwater)
└─**3=Culvert** (Passes 3.49 cfs of 6.64 cfs potential flow)
  ├─**1=Exfiltration** (Exfiltration Controls 0.03 cfs)
  └─**4=Orifice/Grate** (Orifice Controls 3.46 cfs @ 4.41 fps)

Secondary OutFlow Max=1.57 cfs @ 12.12 hrs HW=54.59' TW=49.02' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir** (Weir Controls 1.57 cfs @ 0.72 fps)

Pond 2P: rain garden#2 cascading



Summary for Pond 3P: rain garden#3 cascading

Inflow Area = 1.153 ac, 51.43% Impervious, Inflow Depth > 4.60" for 100 yr event
Inflow = 5.85 cfs @ 12.12 hrs, Volume= 0.442 af
Outflow = 5.83 cfs @ 12.14 hrs, Volume= 0.428 af, Atten= 0%, Lag= 1.0 min
Primary = 5.83 cfs @ 12.14 hrs, Volume= 0.428 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 49.03' @ 12.14 hrs Surf.Area= 969 sf Storage= 1,147 cf
Flood Elev= 50.00' Surf.Area= 1,373 sf Storage= 2,283 cf

Plug-Flow detention time= 55.2 min calculated for 0.428 af (97% of inflow)
Center-of-Mass det. time= 25.0 min (873.5 - 848.5)

Volume	Invert	Avail.Storage	Storage Description
#1	46.00'	1,944 cf	**Rain Garden Envelope (Prismatic)**Listed below (Recalc) 3,144 cf Overall - 1,200 cf Embedded = 1,944 cf
#2	46.00'	120 cf	**crush stone (Prismatic)**Listed below (Recalc) Inside #1 300 cf Overall x 40.0% Voids
#3	46.50'	199 cf	**Bio Media (Prismatic)**Listed below (Recalc) Inside #1 798 cf Overall x 25.0% Voids
#4	47.83'	20 cf	**Mulch (Prismatic)**Listed below (Recalc) Inside #1 102 cf Overall x 20.0% Voids
		2,283 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
46.00	600	0	0
48.00	600	1,200	1,200
49.00	957	779	1,979
50.00	1,373	1,165	3,144

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
46.00	600	0	0
46.50	600	300	300

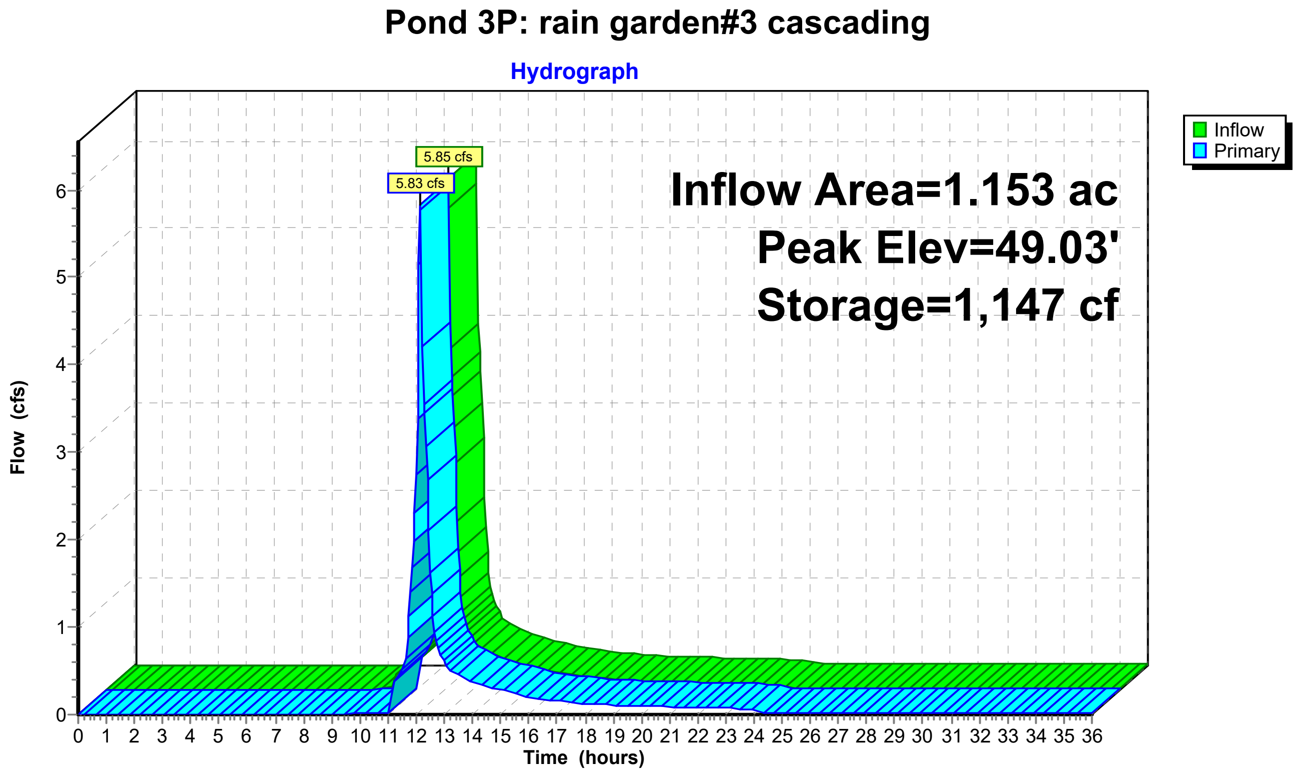
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
46.50	600	0	0
47.83	600	798	798

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
47.83	600	0	0
48.00	600	102	102

Device	Routing	Invert	Outlet Devices
#1	Device 3	46.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Device 3	48.75'	**24.0" x 48.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

#3	Primary	46.00'	**15.0" Round Culvert** L= 26.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 46.00' / 45.87' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf

Primary OutFlow Max=5.64 cfs @ 12.14 hrs HW=49.02' TW=0.00' (Dynamic Tailwater)
└─**3=Culvert** (Passes 5.64 cfs of 7.22 cfs potential flow)
  ├─**1=Exfiltration** (Exfiltration Controls 0.02 cfs)
  └─**2=Orifice/Grate** (Weir Controls 5.62 cfs @ 1.71 fps)



Summary for Pond 4P: UGS-1

Inflow Area = 1.685 ac, 60.12% Impervious, Inflow Depth = 5.10" for 100 yr event
Inflow = 9.49 cfs @ 12.09 hrs, Volume= 0.716 af
Outflow = 8.73 cfs @ 12.14 hrs, Volume= 0.695 af, Atten= 8%, Lag= 2.9 min
Discarded = 0.04 cfs @ 7.20 hrs, Volume= 0.104 af
Primary = 8.69 cfs @ 12.14 hrs, Volume= 0.590 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 43.90' @ 12.14 hrs Surf.Area= 1,672 sf Storage= 4,651 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 79.1 min (872.2 - 793.2)

Volume	Invert	Avail.Storage	Storage Description
#1A	39.50'	2,099 cf	**29.92'W x 55.89'L x 5.50'H Field A** 9,196 cf Overall - 3,198 cf Embedded = 5,998 cf x 35.0% Voids
#2A	40.25'	3,198 cf	**ADS_StormTech MC-3500 d +Cap** x 28 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap 28 Chambers in 4 Rows Cap Storage= +14.9 cf x 2 x 4 rows = 119.2 cf
		5,297 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	39.50'	**24.0" Round Culvert** L= 50.0' Ke= 0.500 Inlet / Outlet Invert= 39.50' / 39.00' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf
#2	Device 1	43.60'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Discarded	39.50'	**1.020 in/hr Exfiltration over Surface area**
#4	Device 1	41.83'	**8.0" Vert. Orifice/Grate X 3.00** C= 0.600

Discarded OutFlow Max=0.04 cfs @ 7.20 hrs HW=39.56' (Free Discharge)
└─**3=Exfiltration** (Exfiltration Controls 0.04 cfs)

Primary OutFlow Max=8.39 cfs @ 12.14 hrs HW=43.87' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Passes 8.39 cfs of 27.77 cfs potential flow)
  ├─**2=Sharp-Crested Rectangular Weir** (Weir Controls 1.80 cfs @ 1.70 fps)
  └─**4=Orifice/Grate** (Orifice Controls 6.59 cfs @ 6.29 fps)

Pond 4P: UGS-1 - Chamber Wizard Field A

Chamber Model = ADS_StormTechMC-3500 d +Cap (ADS StormTech®MC-3500 d rev 03/14 with Cap volume)
Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf
Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap
Cap Storage= +14.9 cf x 2 x 4 rows = 119.2 cf

77.0" Wide + 9.0" Spacing = 86.0" C-C Row Spacing

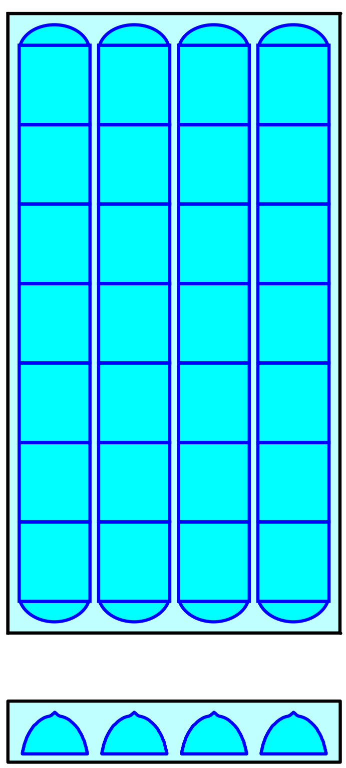
7 Chambers/Row x 7.17' Long +1.85' Cap Length x 2 = 53.89' Row Length +12.0" End Stone x 2 = 55.89' Base Length
4 Rows x 77.0" Wide + 9.0" Spacing x 3 + 12.0" Side Stone x 2 = 29.92' Base Width
9.0" Base + 45.0" Chamber Height + 12.0" Cover = 5.50' Field Height

28 Chambers x 110.0 cf + 14.9 cf Cap Volume x 2 x 4 Rows = 3,197.9 cf Chamber Storage

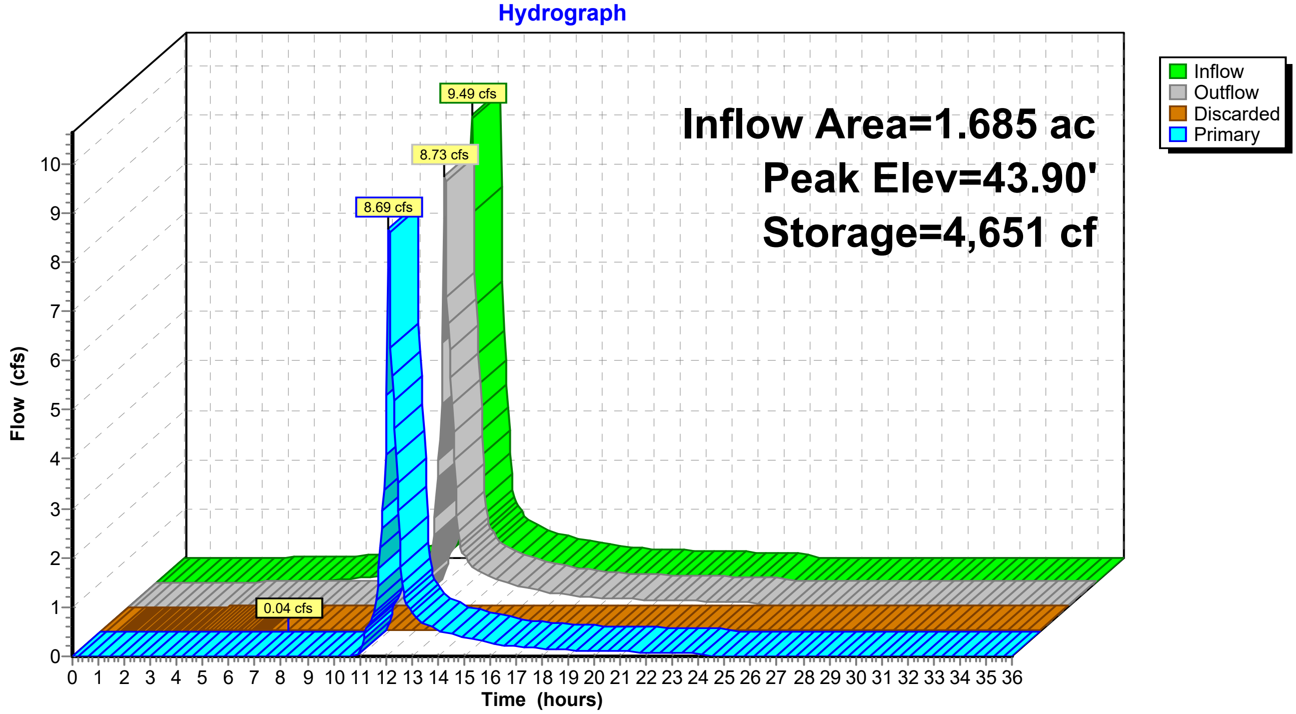
9,196.2 cf Field - 3,197.9 cf Chambers = 5,998.4 cf Stone x 35.0% Voids = 2,099.4 cf Stone Storage

Chamber Storage + Stone Storage = 5,297.3 cf = 0.122 af
Overall Storage Efficiency = 57.6%
Overall System Size = 55.89' x 29.92' x 5.50'

28 Chambers
340.6 cy Field
222.2 cy Stone



Pond 4P: UGS-1


Hydrograph
Inflow
Outflow
Discarded
Primary
9.49 cfs
8.73 cfs
8.69 cfs
0.04 cfs
Inflow Area=1.685 ac
Peak Elev=43.90'
Storage=4,651 cf
Flow (cfs)
0
1
2
3
4
5
6
7
8
9
10
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36
Time (hours)

Summary for Pond BB 01 B: BB 01 B

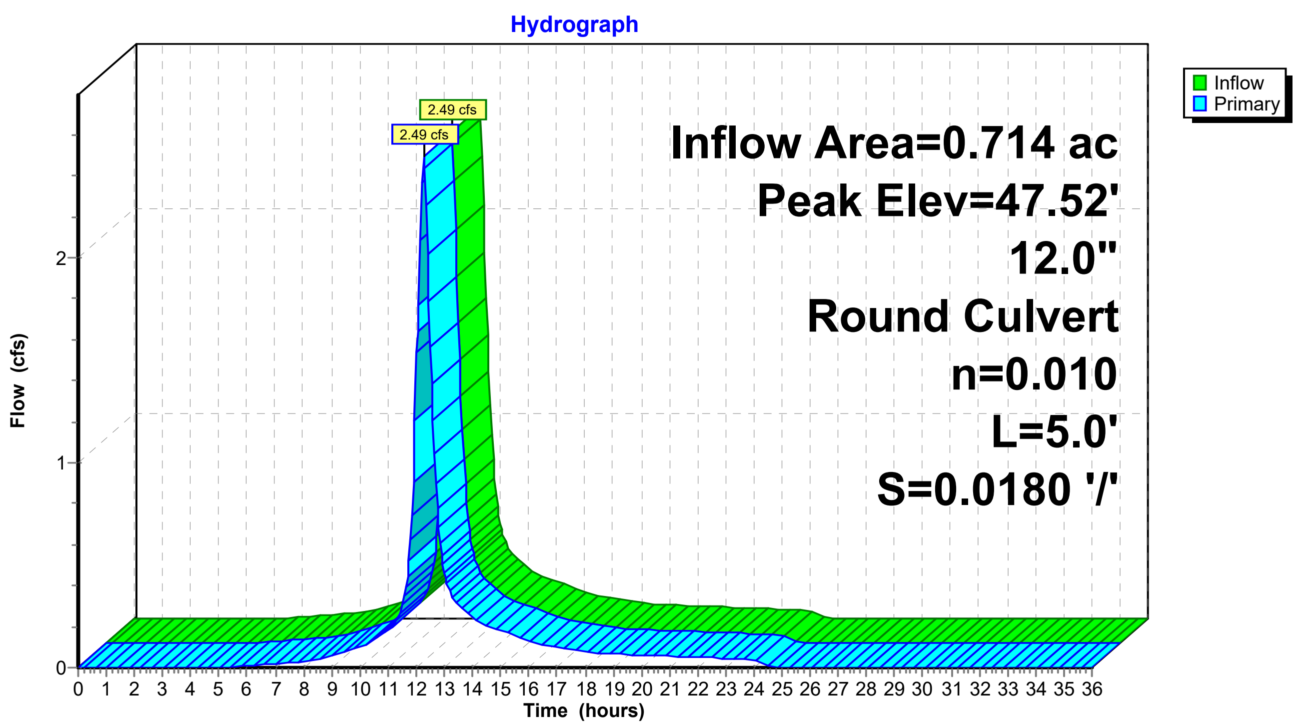
Inflow Area =	0.714 ac,	1.93% Impervious, Inflow Depth = 4.75"	for 100 yr event	
Inflow =	2.49 cfs @	12.26 hrs, Volume=	0.283 af	
Outflow =	2.49 cfs @	12.26 hrs, Volume=	0.283 af,	Atten= 0%, Lag= 0.0 min
Primary =	2.49 cfs @	12.26 hrs, Volume=	0.283 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 47.52' @ 12.55 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	45.90'	**12.0" Round Culvert** L= 5.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 45.90' / 45.81' S= 0.0180 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=1.92 cfs @ 12.26 hrs HW=47.13' TW=46.88' (Dynamic Tailwater)
└**1=Culvert** (Inlet Controls 1.92 cfs @ 2.45 fps)

Pond BB 01 B: BB 01 B



Summary for Pond BB 01 S: BB 01 S

Inflow Area = 0.714 ac, 1.93% Impervious, Inflow Depth = 4.75" for 100 yr event
Inflow = 2.49 cfs @ 12.26 hrs, Volume= 0.283 af
Outflow = 1.38 cfs @ 12.55 hrs, Volume= 0.283 af, Atten= 45%, Lag= 17.4 min
Primary = 1.38 cfs @ 12.55 hrs, Volume= 0.283 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 47.40' @ 12.55 hrs Surf.Area= 0 sf Storage= 2,846 cf

Plug-Flow detention time= 25.8 min calculated for 0.283 af (100% of inflow)
Center-of-Mass det. time= 25.4 min (837.6 - 812.2)

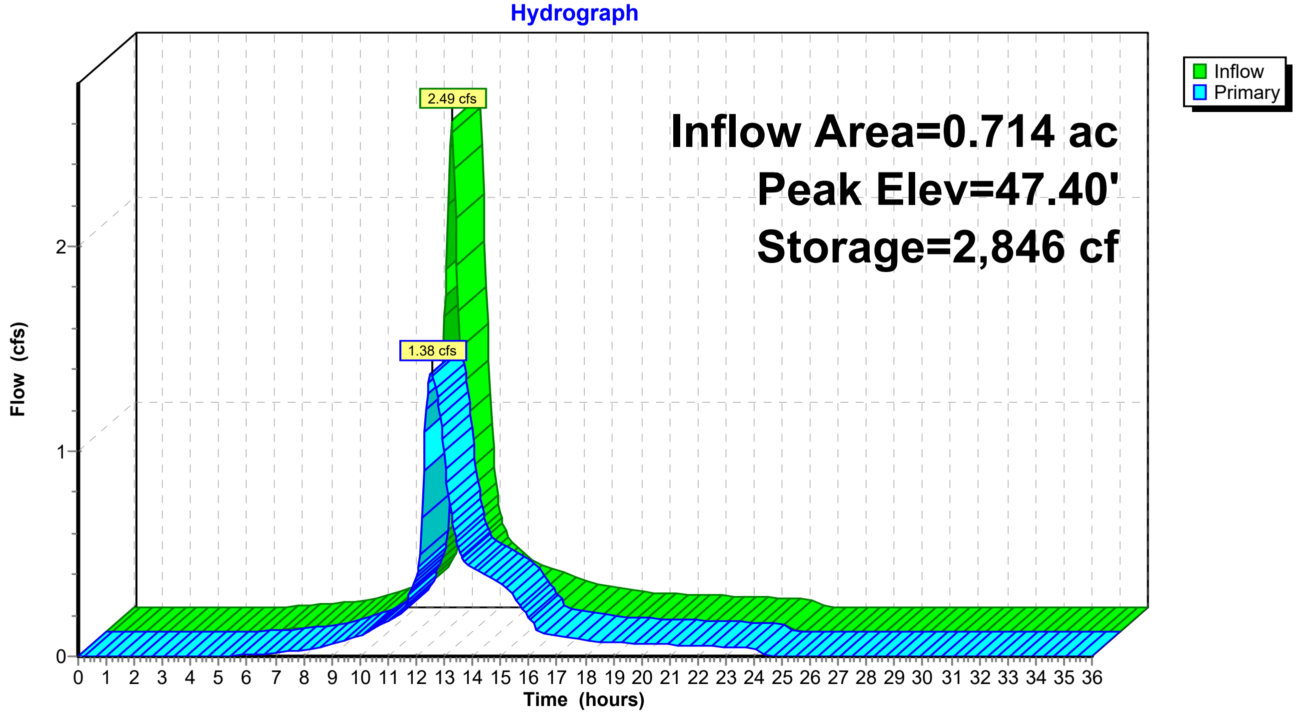
Volume	Invert	Avail.Storage	Storage Description
#1	44.97'	3,256 cf	**Custom Stage Data**Listed below

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
44.97	0	0
45.30	16	16
45.80	236	252
46.30	825	1,077
46.80	876	1,953
47.30	792	2,745
47.80	511	3,256

Device	Routing	Invert	Outlet Devices
#1	Primary	44.97'	**4.0" Round Culvert** L= 8.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 44.97' / 44.87' S= 0.0125 '/' Cc= 0.900 n= 0.010, Flow Area= 0.09 sf
#2	Primary	46.40'	**6.0" Round Culvert** L= 5.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 46.40' / 46.30' S= 0.0200 '/' Cc= 0.900 n= 0.010, Flow Area= 0.20 sf

Primary OutFlow Max=1.38 cfs @ 12.55 hrs HW=47.40' TW=45.59' (Dynamic Tailwater)
1=Culvert (Inlet Controls 0.56 cfs @ 6.47 fps)
2=Culvert (Inlet Controls 0.82 cfs @ 4.17 fps)

Pond BB 01 S: BB 01 S



Summary for Pond BB 06 B: BB 06 B

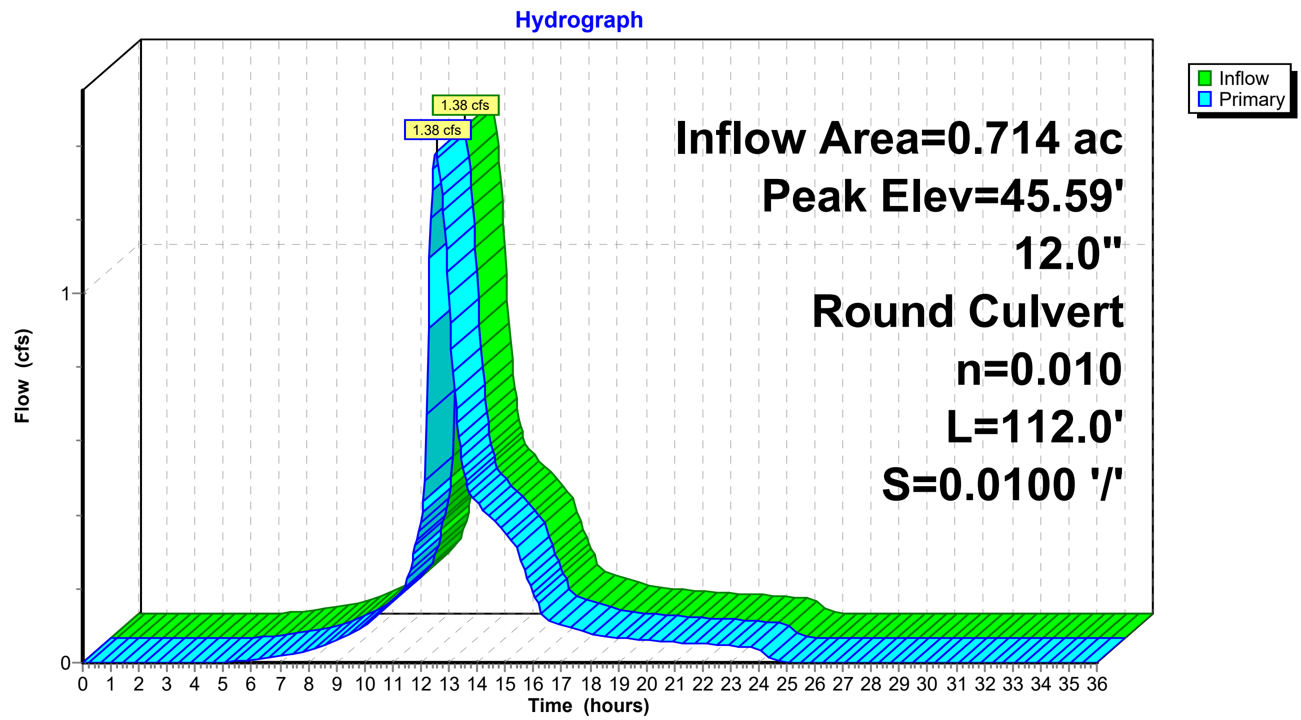
Inflow Area =	0.714 ac,	1.93% Impervious,	Inflow Depth = 4.75"	for 100 yr event
Inflow =	1.38 cfs @	12.55 hrs, Volume=	0.283 af	
Outflow =	1.38 cfs @	12.55 hrs, Volume=	0.283 af, Atten= 0%, Lag= 0.0 min	
Primary =	1.38 cfs @	12.55 hrs, Volume=	0.283 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 45.59' @ 12.55 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	44.97'	**12.0" Round Culvert** L= 112.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 44.97' / 43.85' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=1.38 cfs @ 12.55 hrs HW=45.59' TW=43.33' (Dynamic Tailwater)
└1=Culvert (Inlet Controls 1.38 cfs @ 2.69 fps)

Pond BB 06 B: BB 06 B



Summary for Pond BB 11 B: BB 11 B

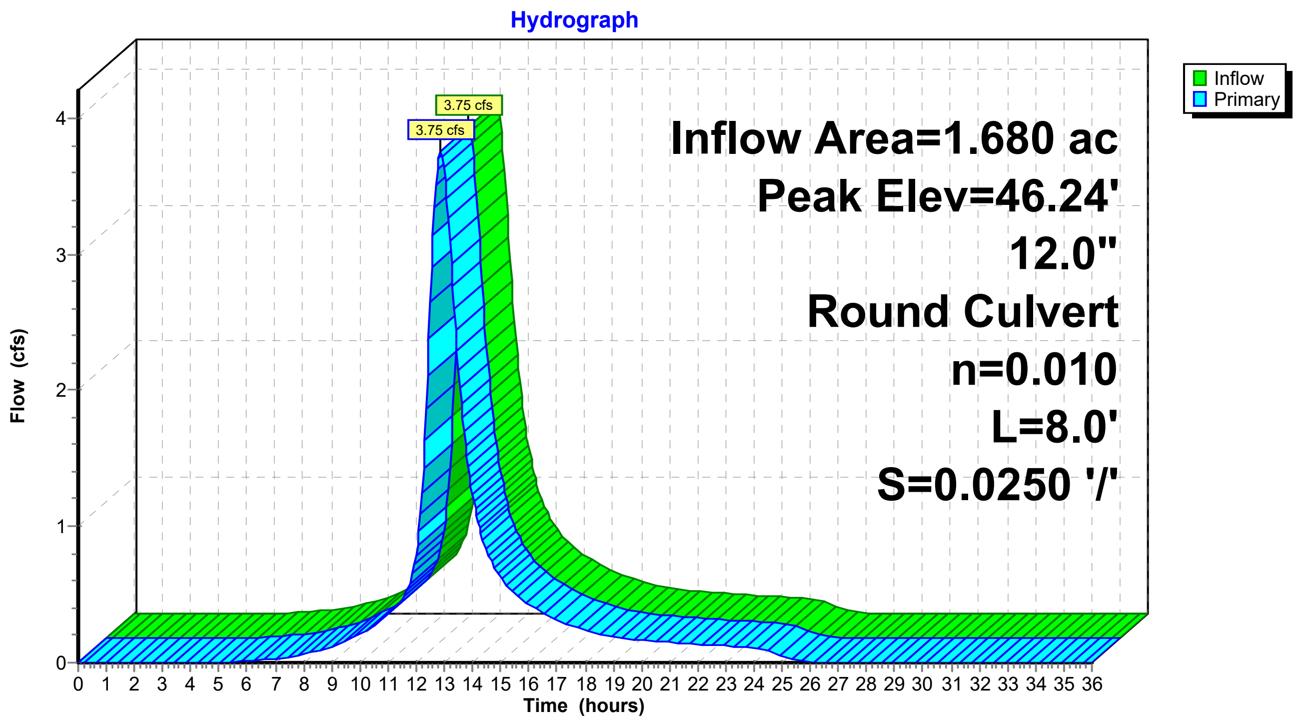
Inflow Area =	1.680 ac,	0.00% Impervious,	Inflow Depth = 5.25"	for 100 yr event	
Inflow =	3.75 cfs @	12.87 hrs,	Volume=	0.736 af	
Outflow =	3.75 cfs @	12.87 hrs,	Volume=	0.736 af,	Atten= 0%, Lag= 0.0 min
Primary =	3.75 cfs @	12.87 hrs,	Volume=	0.736 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 46.24' @ 13.10 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	44.00'	**12.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 44.00' / 43.80' S= 0.0250 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=3.54 cfs @ 12.87 hrs HW=46.01' TW=45.13' (Dynamic Tailwater)
1=Culvert (Inlet Controls 3.54 cfs @ 4.50 fps)

Pond BB 11 B: BB 11 B



Summary for Pond BB 11 S: BB 11 S

Inflow Area = 1.680 ac, 0.00% Impervious, Inflow Depth = 5.25" for 100 yr event
Inflow = 3.75 cfs @ 12.87 hrs, Volume= 0.736 af
Outflow = 3.24 cfs @ 13.16 hrs, Volume= 0.736 af, Atten= 14%, Lag= 17.6 min
Primary = 3.24 cfs @ 13.16 hrs, Volume= 0.736 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 45.49' @ 13.16 hrs Surf.Area= 0 sf Storage= 3,794 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 11.3 min (862.8 - 851.5)

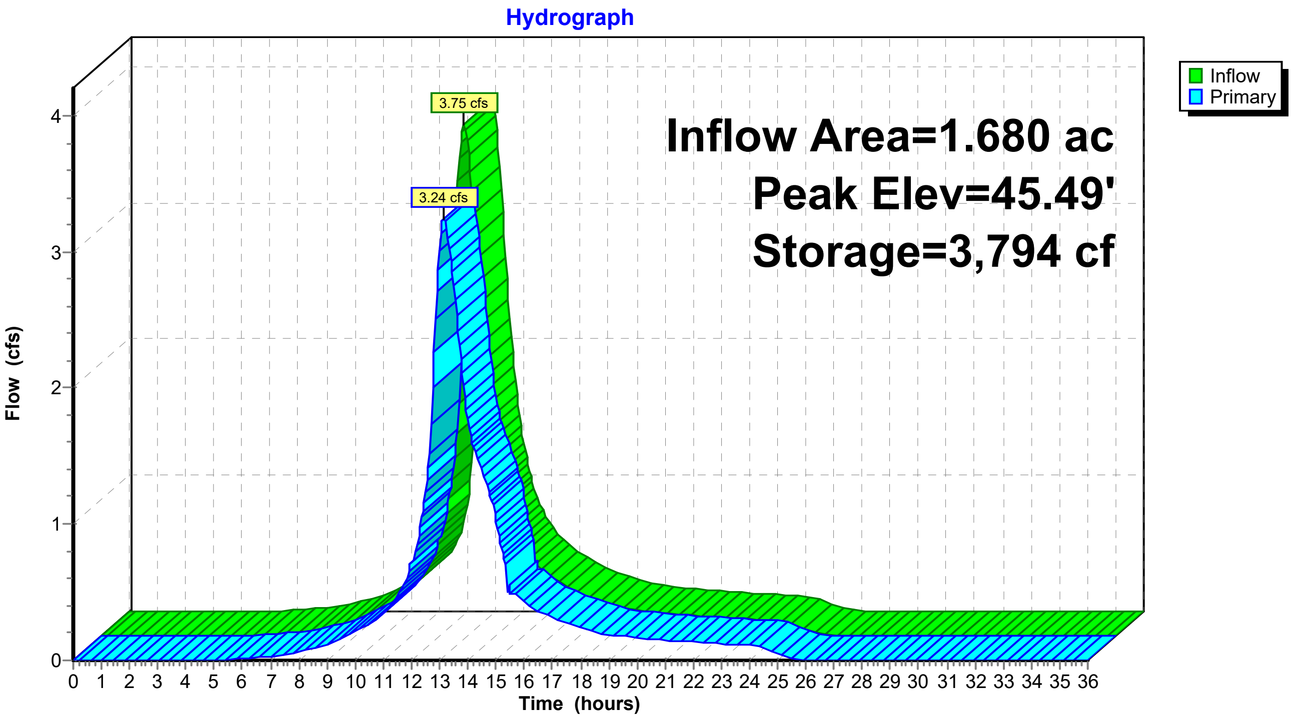
Volume	Invert	Avail.Storage	Storage Description
#1	42.97'	4,778 cf	**Custom Stage Data**Listed below

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
42.97	0	0
43.30	16	16
43.80	481	497
44.30	963	1,460
44.80	1,019	2,479
45.30	1,085	3,564
45.80	603	4,167
46.30	611	4,778

Device	Routing	Invert	Outlet Devices
#1	Primary	42.97'	**4.0" Round Culvert** L= 16.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 42.97' / 42.81' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.09 sf
#2	Primary	39.70'	**6.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 39.70' / 39.60' S= 0.0125 '/' Cc= 0.900 n= 0.010, Flow Area= 0.20 sf
#3	Primary	44.50'	**8.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 44.50' / 44.40' S= 0.0125 '/' Cc= 0.900 n= 0.010, Flow Area= 0.35 sf

Primary OutFlow Max=3.24 cfs @ 13.16 hrs HW=45.49' TW=43.59' (Dynamic Tailwater)
├─**1=Culvert** (Outlet Controls 0.58 cfs @ 6.63 fps)
├─**2=Culvert** (Inlet Controls 1.30 cfs @ 6.64 fps)
└─**3=Culvert** (Inlet Controls 1.36 cfs @ 3.90 fps)

Pond BB 11 S: BB 11 S



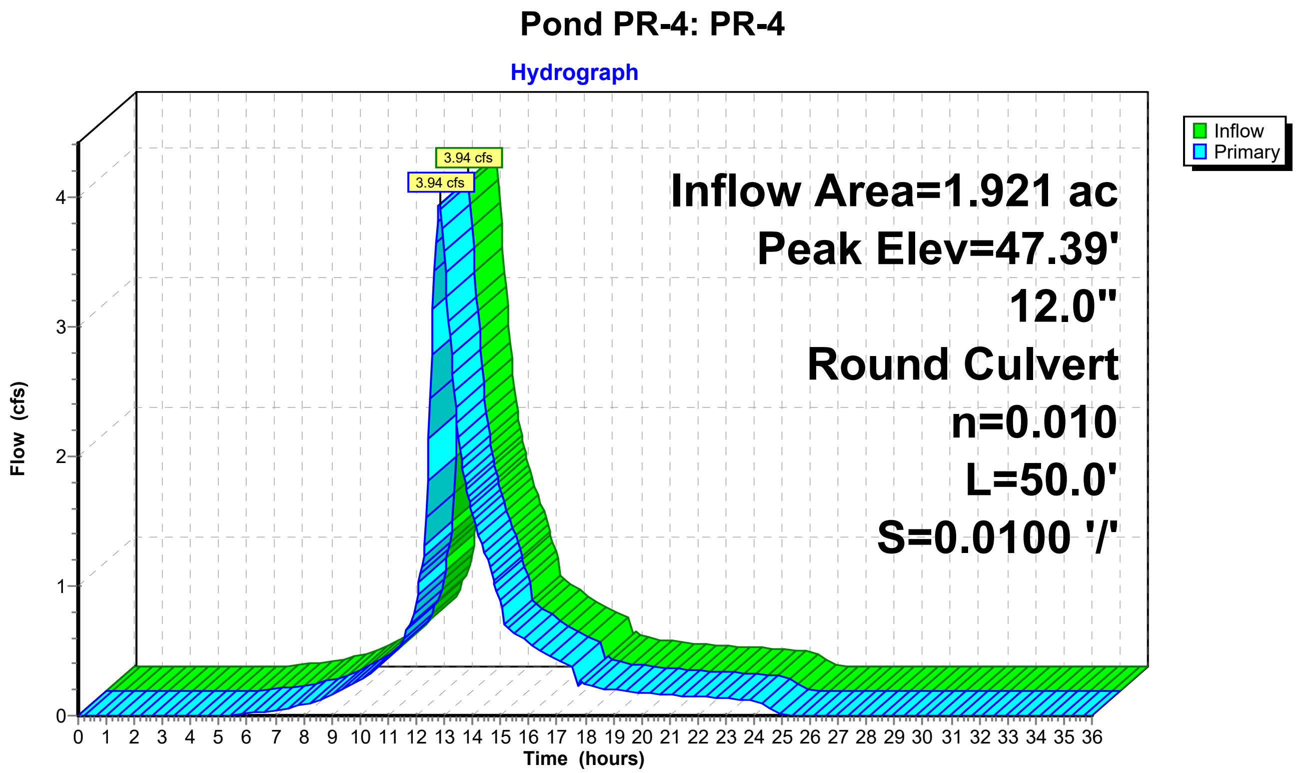
Summary for Pond PR-4: PR-4

Inflow Area = 1.921 ac, 1.30% Impervious, Inflow Depth = 5.13" for 100 yr event
Inflow = 3.94 cfs @ 12.83 hrs, Volume= 0.821 af
Outflow = 3.94 cfs @ 12.83 hrs, Volume= 0.821 af, Atten= 0%, Lag= 0.0 min
Primary = 3.94 cfs @ 12.83 hrs, Volume= 0.821 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 47.39' @ 12.83 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	45.80'	**12.0" Round Culvert** L= 50.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 45.80' / 45.30' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=3.93 cfs @ 12.83 hrs HW=47.38' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 3.93 cfs @ 5.01 fps)



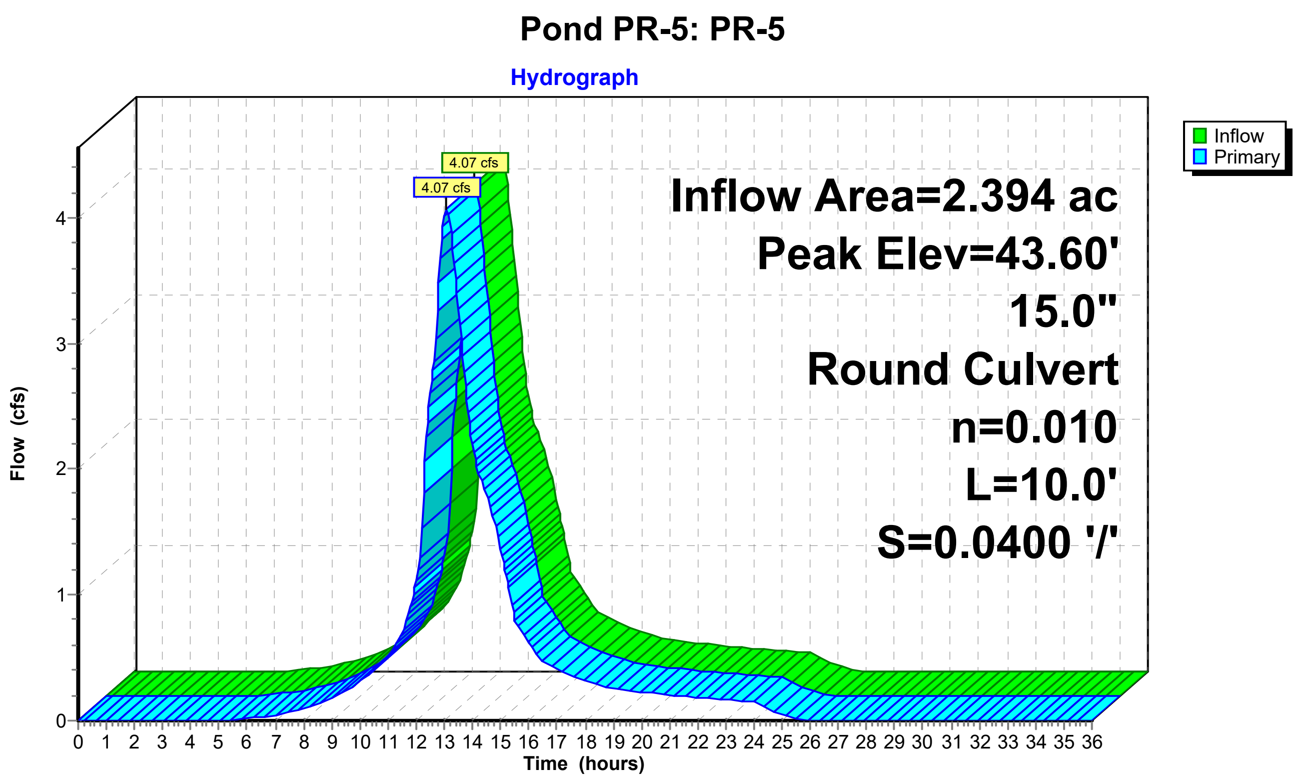
Summary for Pond PR-5: PR-5

Inflow Area = 2.394 ac, 0.58% Impervious, Inflow Depth = 5.10" for 100 yr event
Inflow = 4.07 cfs @ 13.09 hrs, Volume= 1.018 af
Outflow = 4.07 cfs @ 13.09 hrs, Volume= 1.018 af, Atten= 0%, Lag= 0.0 min
Primary = 4.07 cfs @ 13.09 hrs, Volume= 1.018 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 43.60' @ 13.09 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	42.50'	**15.0" Round Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 42.50' / 42.10' S= 0.0400 '/' Cc= 0.900 n= 0.010, Flow Area= 1.23 sf

Primary OutFlow Max=4.06 cfs @ 13.09 hrs HW=43.60' TW=0.00' (Dynamic Tailwater)
1=Culvert (Inlet Controls 4.06 cfs @ 3.56 fps)



Summary for Pond SB 01 B: SB 01 B

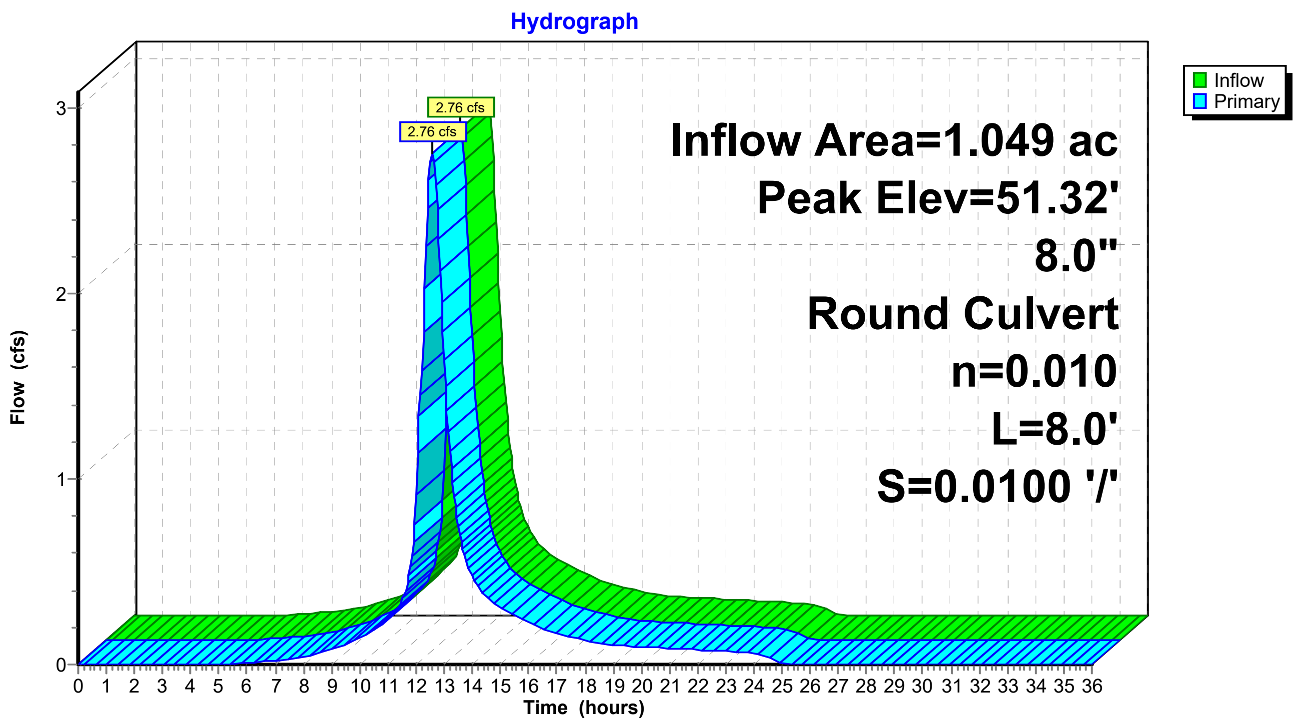
Inflow Area = 1.049 ac, 2.38% Impervious, Inflow Depth = 5.03" for 100 yr event
Inflow = 2.76 cfs @ 12.56 hrs, Volume= 0.440 af
Outflow = 2.76 cfs @ 12.56 hrs, Volume= 0.440 af, Atten= 0%, Lag= 0.0 min
Primary = 2.76 cfs @ 12.56 hrs, Volume= 0.440 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 51.32' @ 12.56 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	48.30'	**8.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 48.30' / 48.22' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.35 sf

Primary OutFlow Max=2.75 cfs @ 12.56 hrs HW=51.31' TW=48.41' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 2.75 cfs @ 7.88 fps)

Pond SB 01 B: SB 01 B



Summary for Pond SB 01 S: SB 01 S

Inflow Area = 1.049 ac, 2.38% Impervious, Inflow Depth = 5.03" for 100 yr event
Inflow = 2.76 cfs @ 12.56 hrs, Volume= 0.440 af
Outflow = 1.99 cfs @ 12.87 hrs, Volume= 0.440 af, Atten= 28%, Lag= 18.3 min
Primary = 1.99 cfs @ 12.87 hrs, Volume= 0.440 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 48.98' @ 12.90 hrs Surf.Area= 0 sf Storage= 3,258 cf

Plug-Flow detention time= 16.0 min calculated for 0.439 af (100% of inflow)
Center-of-Mass det. time= 16.0 min (846.5 - 830.5)

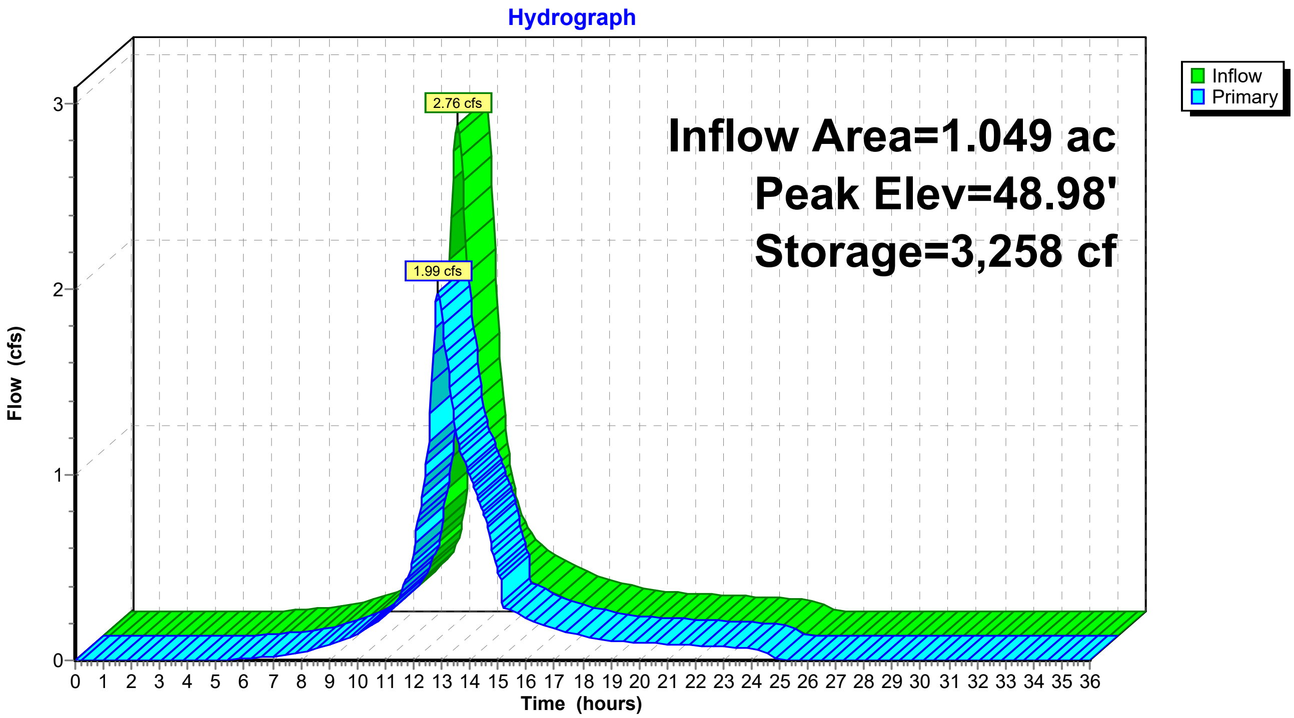
Volume	Invert	Avail.Storage	Storage Description
#1	46.30'	4,121 cf	**Custom Stage Data**Listed below

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
46.30	0	0
46.80	16	16
47.30	386	402
47.80	837	1,239
48.30	886	2,125
48.80	943	3,068
49.30	523	3,591
49.80	530	4,121

Device	Routing	Invert	Outlet Devices
#1	Primary	46.30'	**6.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 46.30' / 46.20' S= 0.0125 '/' Cc= 0.900 n= 0.010, Flow Area= 0.20 sf
#2	Primary	48.30'	**8.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 48.30' / 48.22' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.35 sf

Primary OutFlow Max=1.96 cfs @ 12.87 hrs HW=48.97' TW=47.66' (Dynamic Tailwater)
├─**1=Culvert** (Inlet Controls 1.09 cfs @ 5.53 fps)
└─**2=Culvert** (Barrel Controls 0.87 cfs @ 3.07 fps)

Pond SB 01 S: SB 01 S



Summary for Pond SB 03 B: SB 03B

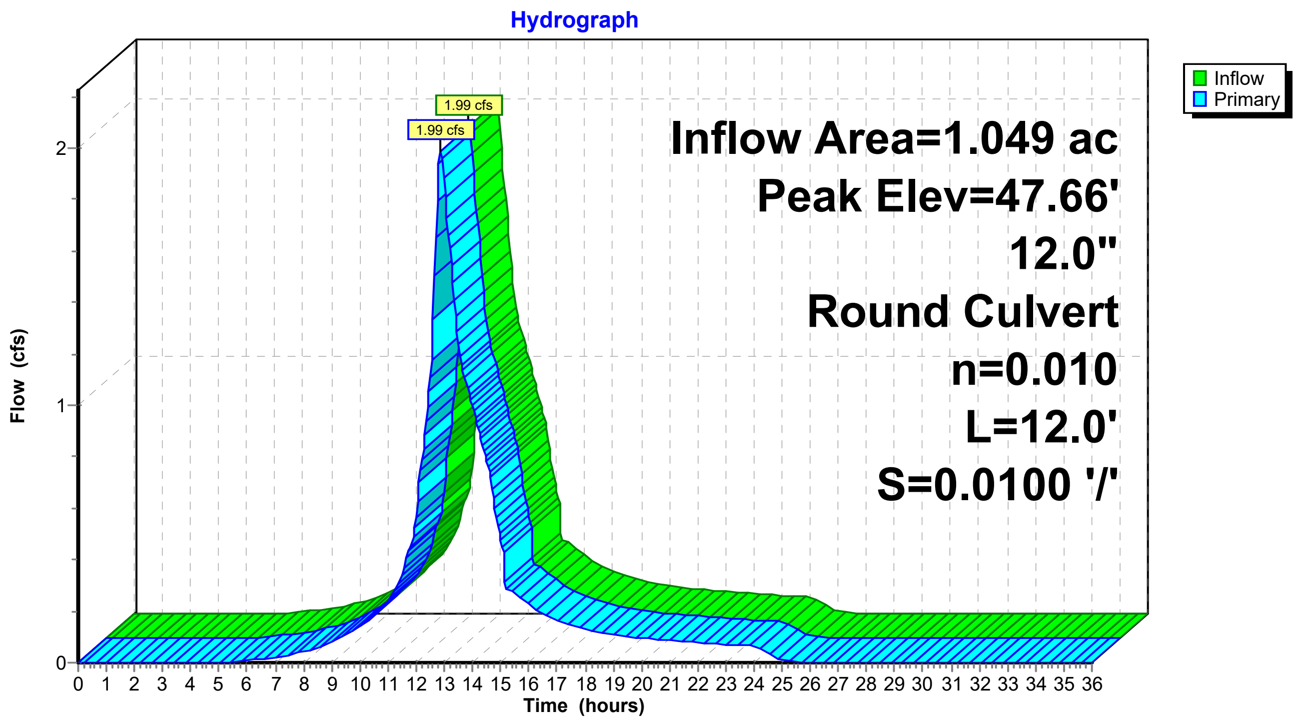
Inflow Area =	1.049 ac,	2.38% Impervious,	Inflow Depth = 5.03"	for 100 yr event
Inflow =	1.99 cfs @	12.87 hrs, Volume=	0.440 af	
Outflow =	1.99 cfs @	12.87 hrs, Volume=	0.440 af, Atten= 0%, Lag= 0.0 min	
Primary =	1.99 cfs @	12.87 hrs, Volume=	0.440 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 47.66' @ 12.88 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	46.25'	**12.0" Round Culvert** L= 12.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 46.25' / 46.13' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=2.02 cfs @ 12.87 hrs HW=47.66' TW=47.37' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 2.02 cfs @ 2.57 fps)

Pond SB 03 B: SB 03B



Summary for Pond SB 11 B: SB 11 B

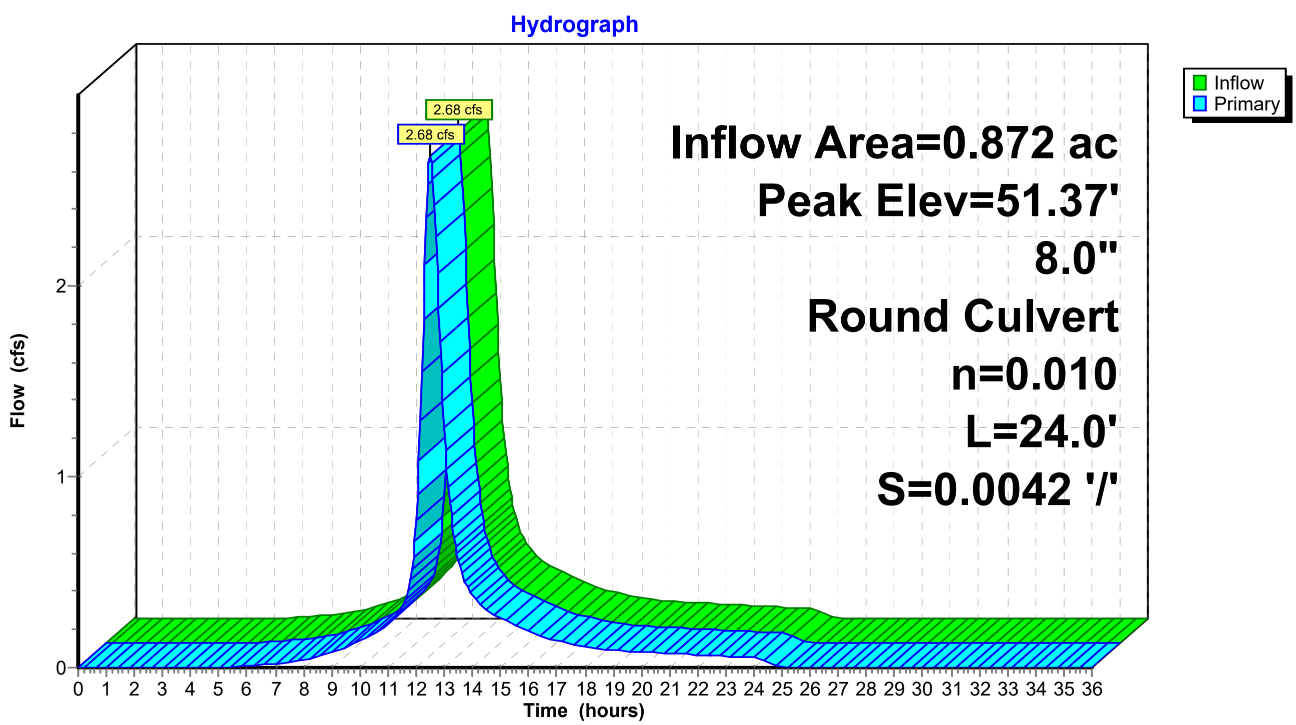
Inflow Area =	0.872 ac,	0.00% Impervious, Inflow Depth =	5.25"	for 100 yr event
Inflow =	2.68 cfs @	12.50 hrs, Volume=	0.382 af	
Outflow =	2.68 cfs @	12.50 hrs, Volume=	0.382 af, Atten= 0%, Lag= 0.0 min	
Primary =	2.68 cfs @	12.50 hrs, Volume=	0.382 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 51.37' @ 12.50 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	48.50'	**8.0" Round Culvert** L= 24.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 48.50' / 48.40' S= 0.0042 '/' Cc= 0.900 n= 0.010, Flow Area= 0.35 sf

Primary OutFlow Max=2.68 cfs @ 12.50 hrs HW=51.37' TW=48.74' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 2.68 cfs @ 7.66 fps)

Pond SB 11 B: SB 11 B



Summary for Pond SB 11 S: SB 11 S

Inflow Area = 0.872 ac, 0.00% Impervious, Inflow Depth = 5.25" for 100 yr event
Inflow = 2.68 cfs @ 12.50 hrs, Volume= 0.382 af
Outflow = 2.01 cfs @ 12.75 hrs, Volume= 0.382 af, Atten= 25%, Lag= 15.2 min
Primary = 2.01 cfs @ 12.75 hrs, Volume= 0.382 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 49.23' @ 12.77 hrs Surf.Area= 0 sf Storage= 3,318 cf

Plug-Flow detention time= 29.6 min calculated for 0.381 af (100% of inflow)
Center-of-Mass det. time= 29.5 min (853.7 - 824.2)

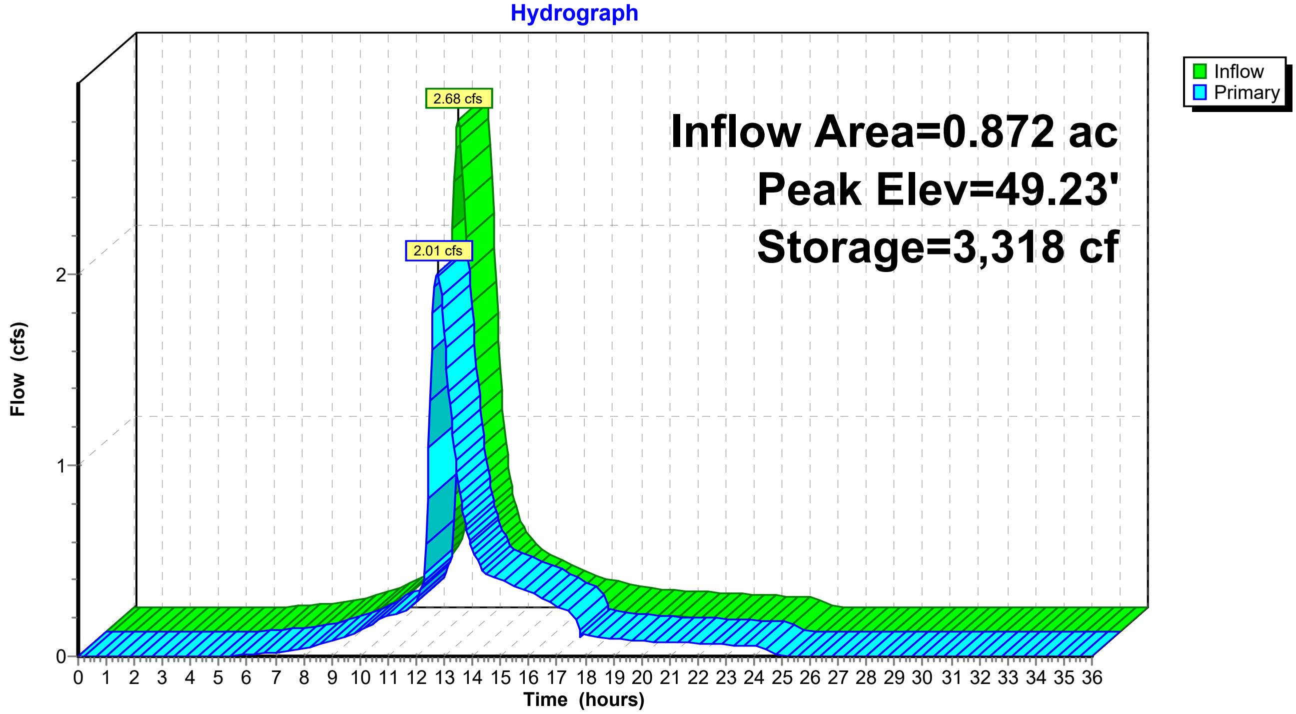
Volume	Invert	Avail.Storage	Storage Description
#1	46.80'	3,953 cf	**Custom Stage Data**Listed below

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
46.80	0	0
47.30	16	16
47.80	888	904
48.30	944	1,848
48.80	1,001	2,849
49.30	544	3,393
49.80	560	3,953

Device	Routing	Invert	Outlet Devices
#1	Primary	46.80'	**4.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 46.80' / 46.72' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.09 sf
#2	Primary	48.10'	**8.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 48.10' / 48.00' S= 0.0125 '/' Cc= 0.900 n= 0.010, Flow Area= 0.35 sf

Primary OutFlow Max=2.00 cfs @ 12.75 hrs HW=49.23' TW=47.81' (Dynamic Tailwater)
1=Culvert (Inlet Controls 0.50 cfs @ 5.73 fps)
2=Culvert (Inlet Controls 1.50 cfs @ 4.29 fps)

Pond SB 11 S: SB 11 S



Summary for Pond SB 12 B: SB 12 B

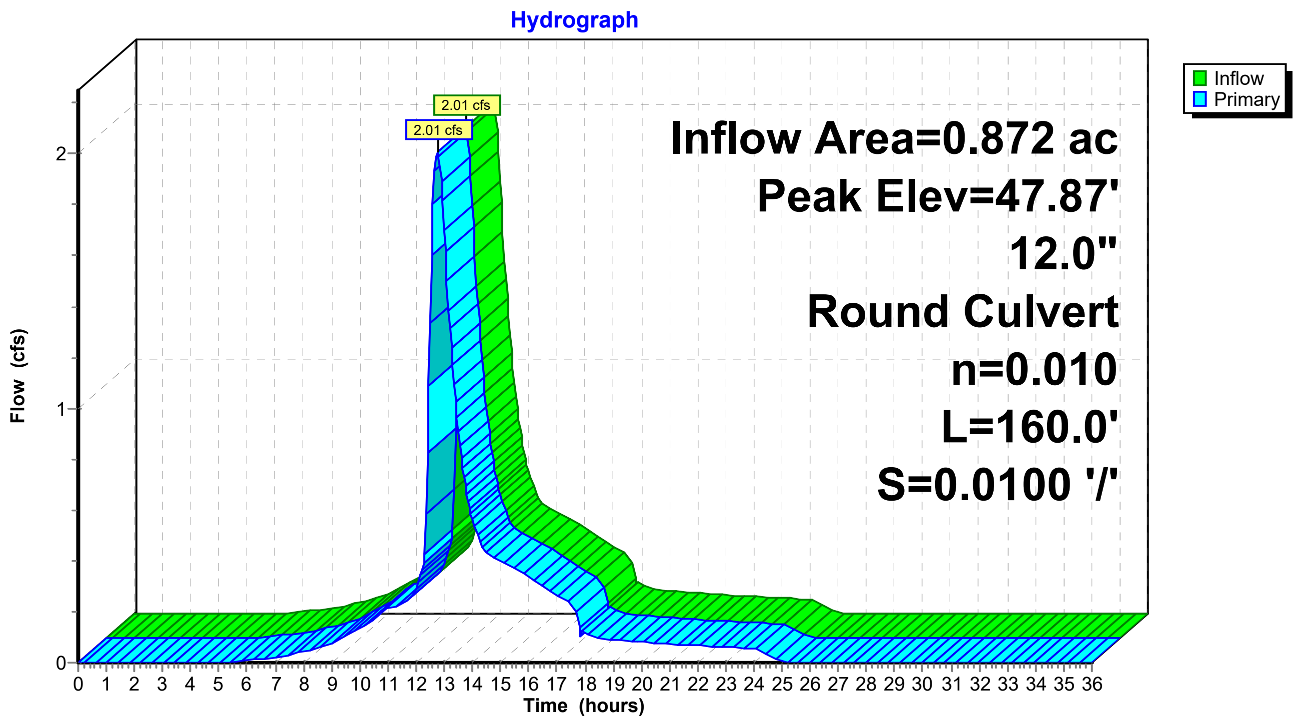
Inflow Area =	0.872 ac,	0.00% Impervious, Inflow Depth = 5.25"	for 100 yr event	
Inflow =	2.01 cfs @	12.75 hrs, Volume=	0.382 af	
Outflow =	2.01 cfs @	12.75 hrs, Volume=	0.382 af,	Atten= 0%, Lag= 0.0 min
Primary =	2.01 cfs @	12.75 hrs, Volume=	0.382 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 47.87' @ 12.86 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	46.80'	**12.0" Round Culvert** L= 160.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 46.80' / 45.20' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=1.86 cfs @ 12.75 hrs HW=47.81' TW=47.32' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 1.86 cfs @ 2.90 fps)

Pond SB 12 B: SB 12 B

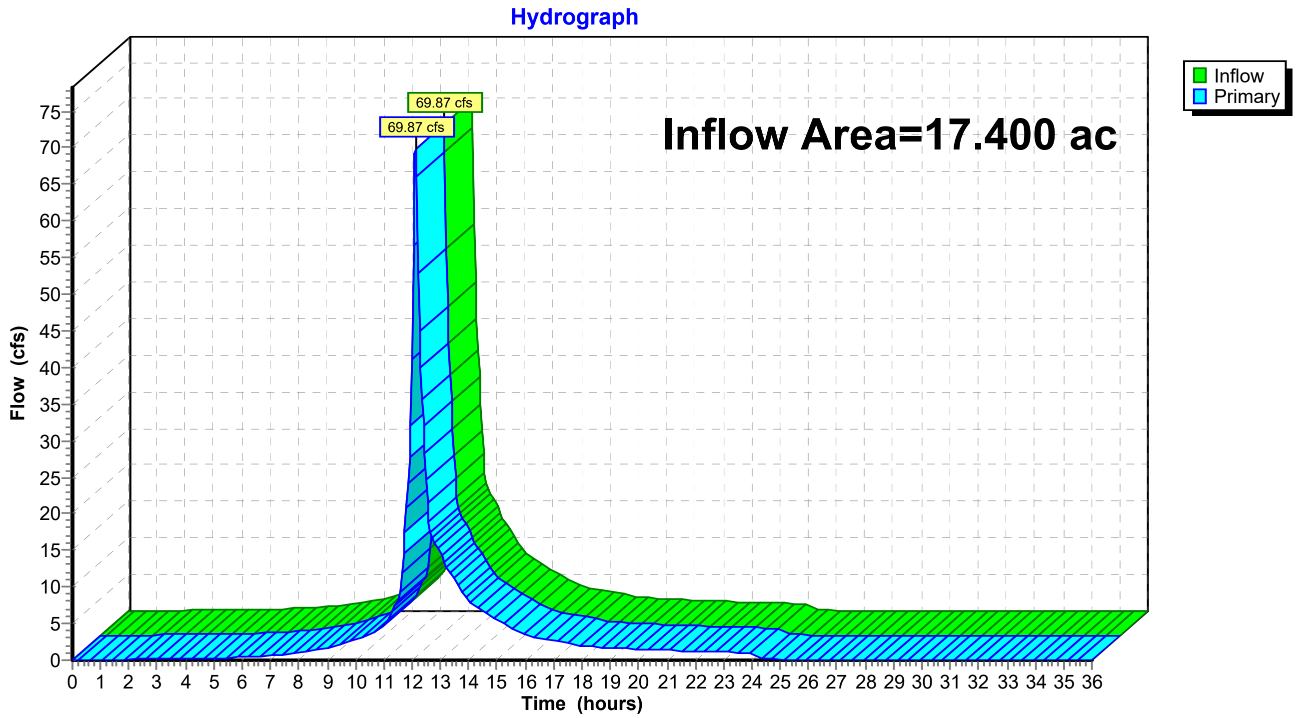


Summary for Link POA: POA

Inflow Area = 17.400 ac, 49.60% Impervious, Inflow Depth > 5.15" for 100 yr event
Inflow = 69.87 cfs @ 12.11 hrs, Volume= 7.475 af
Primary = 69.87 cfs @ 12.11 hrs, Volume= 7.475 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Link POA: POA



APPENDIX 3:

Test Pit Logs

Soils Report

Commonwealth of Massachusetts
City/Town of Arlington

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

A. Facility Information

Town of Arlington
Owner Name

869 Massachusetts Ave
Street Address

53-2-4
Map/Lot #

Arlington
City

MA
State

02476
Zip Code

B. Site Information

1. (Check one) ☐ New Construction ☐ Upgrade ☐ Repair

2. Soil Survey Available? ☒ Yes ☐ No If yes: USDA (Source) 656 (Soil Map Unit)

   Udorthents
   Soil Name

   Soil Limitations

   Loamy alluvium and/or sandy glaciofluvial deposits and/or loamy glaciolacustrine deposits

   Urban Land
   Landform

3. Surficial Geological Report Available? ☒ Yes ☐ No If yes: 2018/Stone (Year Published/Source) Artificial Fill (Map Unit)

   Earth materials and manmade materials that have been artificially emplaced.
   Description of Geologic Map Unit:

4. Flood Rate Insurance Map Within a regulatory floodway? ☐ Yes ☒ No

5. Within a velocity zone? ☐ Yes ☒ No

6. Within a Mapped Wetland Area? ☐ Yes ☒ No If yes, MassGIS Wetland Data Layer: N/A (Wetland Type)

7. Current Water Resource Conditions (USGS): 1015/19 (Month/Day/ Year) Range: ☐ Above Normal ☒ Normal ☐ Below Normal

8. Other references reviewed:

Commonwealth of Massachusetts
City/Town of Arlington

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review *(minimum of two holes required at every proposed primary and reserve disposal area)*

Deep Observation Hole Number: TP-1 (Hole #) | 10/14/19 (Date) | 11:00 (Time) | Sunny, 50's (Weather) | ______ (Latitude) | ______ (Longitude:)

1. Land Use: Landscaped area (e.g., woodland, agricultural field, vacant lot, etc.) | Grass (Vegetation) | None (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | 0-2% (Slope (%))

   Description of Location: ______

2. Soil Parent Material: Loamy alluvium | Outwash plain (Landform) | BS (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body 100'+ feet | Drainage Way 100'+ feet | Wetlands 100'+ feet

   Property Line 20'+ feet | Drinking Water Well 100'+ feet | Other ______ feet

4. Unsuitable Materials Present: ☒ Yes ☐ No If Yes: ☐ Disturbed Soil ☒ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☒ Yes ☐ No If yes: 90" Depth Weeping from Pit 96" Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-36	Fill										
36-48	Ab	Sandy Loam	10YR3/1						Granular	Friable	
48-96	C1	Sandy Loam	2.5Y 5/4				3%	3%	Massive	Friable	

Additional Notes:
NRCS Hydrologic Soil Group B; ESHGW=37.00

Commonwealth of Massachusetts
City/Town of Arlington

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review (*minimum of two holes required at every proposed primary and reserve disposal area)*

Deep Observation Hole Number: ______ Hole # ______ Date ______ Time ______ Weather ______ Latitude ______ Longitude:

1. Land Use: ______ (e.g., woodland, agricultural field, vacant lot, etc.) ______ Vegetation ______ Surface Stones (e.g., cobbles, stones, boulders, etc.) ______ Slope (%)

   Description of Location: ______

2. Soil Parent Material: ______ ______ Landform ______ Position on Landscape (SU, SH, BS, FS, TS)

3. Distances from: Open Water Body ______ feet Drainage Way ______ feet Wetlands ______ feet
   Property Line ______ feet Drinking Water Well ______ feet Other ______ feet

4. Unsuitable Materials Present: ☐ Yes ☐ No If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☐ No If yes: ______ Depth Weeping from Pit ______ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA)	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			

Additional Notes:

______

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

D. Determination of High Groundwater Elevation

1. Method Used: Obs. Hole # TP-1 Obs. Hole # _____

	Obs. Hole # TP-1	Obs. Hole # _____
☐ Depth observed standing water in observation hole	_____ inches	_____ inches
☒ Depth weeping from side of observation hole	90" inches	_____ inches
☐ Depth to soil redoximorphic features (mottles)	_____ inches	_____ inches
☐ Depth to adjusted seasonal high groundwater (S_h) (USGS methodology)	_____ inches	_____ inches

_____ Index Well Number _____ Reading Date

$S_h = S_c - [S_r \times (OW_c - OW_{max})/OW_r]$

Obs. Hole/Well# _____ S_c _____ S_r _____ OW_c _____ OW_{max} _____ OW_r _____ S_h _____

2. Estimated Depth to High Groundwater: 90" inches

E. Depth of Pervious Material

1. Depth of Naturally Occurring Pervious Material

a. Does at least four feet of naturally occurring pervious material exist in all areas observed throughout the area proposed for the soil absorption system?

☒ Yes ☐ No

b. If yes, at what depth was it observed (exclude A and O Horizons)? Upper boundary: 48" inches Lower boundary: 96" inches

c. If no, at what depth was impervious material observed? Upper boundary: _____ inches Lower boundary: _____ inches

Commonwealth of Massachusetts
City/Town of Arlington

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

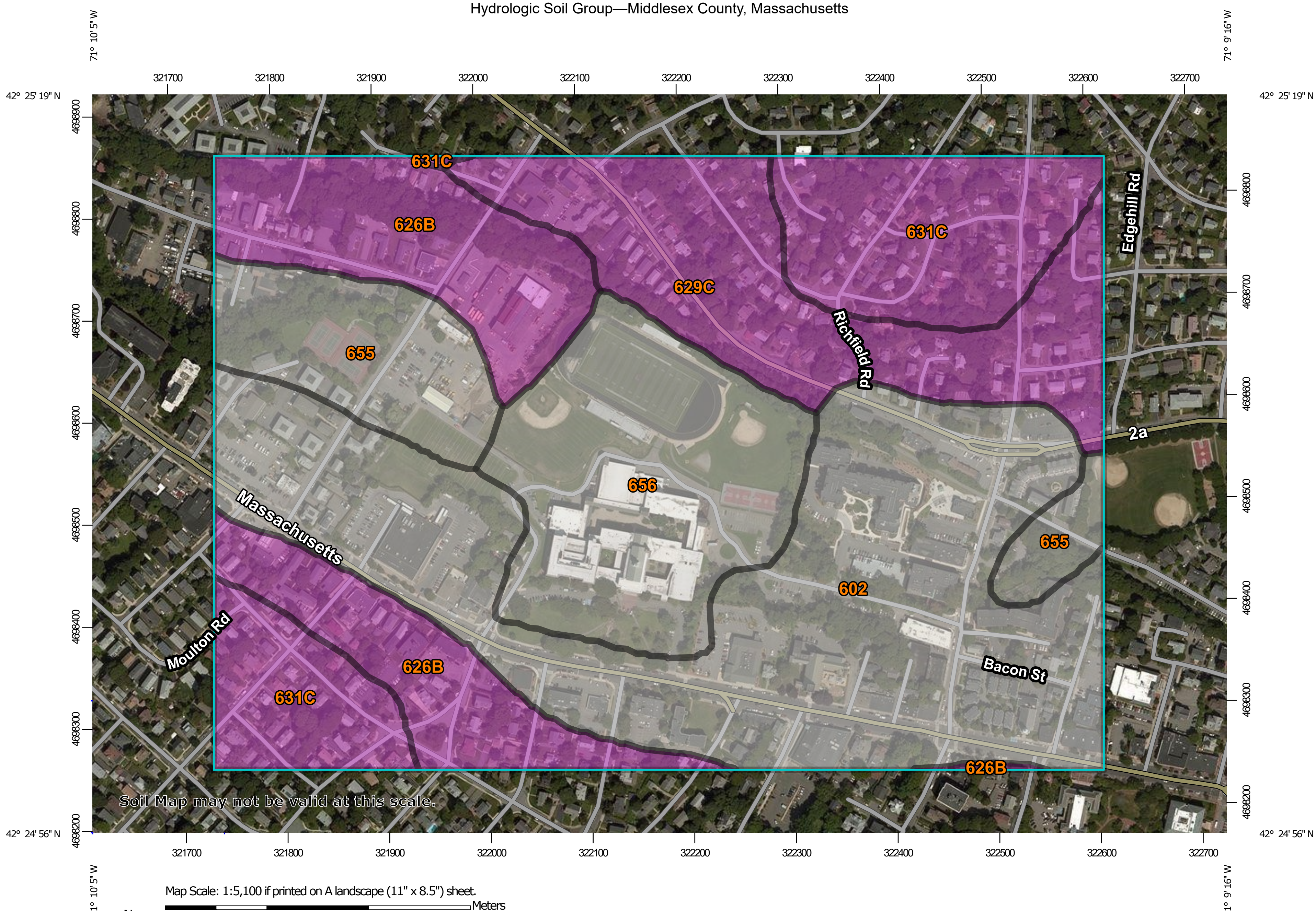
F. Certification

I certify that I am currently approved by the Department of Environmental Protection pursuant to 310 CMR 15.017 to conduct soil evaluations and that the above analysis has been performed by me consistent with the required training, expertise and experience described in 310 CMR 15.017. I further certify that the results of my soil evaluation, as indicated in the attached Soil Evaluation Form, are accurate and in accordance with 310 CMR 15.100 through 15.107.

David Scharlacken	10-15-19
Signature of Soil Evaluator	Date
David Scharlacken SE#14279	12/1/2021
Typed or Printed Name of Soil Evaluator / License #	Expiration Date of License
Name of Approving Authority Witness	Approving Authority

Note: In accordance with 310 CMR 15.018(2) this form must be submitted to the approving authority within 60 days of the date of field testing, and to the designer and the property owner with Percolation Test Form 12.

Field Diagrams: Use this area for field diagrams:



Map Scale: 1:5,100 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 50, 100, 200, 300

Feet: 0, 200, 400, 800, 1200

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:25,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Middlesex County, Massachusetts
Survey Area Data: Version 18, Sep 7, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Aug 10, 2014—Aug 25, 2014

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
602	Urban land		44.3	33.9%
626B	Merrimac-Urban land complex, 0 to 8 percent slopes	A	20.3	15.5%
629C	Canton-Charlton-Urban land complex, 3 to 15 percent slopes	A	18.5	14.1%
631C	Charlton-Urban land-Hollis complex, 3 to 15 percent slopes, rocky	A	17.4	13.3%
655	Udorthents, wet substratum		11.1	8.5%
656	Udorthents-Urban land complex		19.1	14.6%
Totals for Area of Interest			**130.7**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

APPENDIX 4:
Operations and Maintenance Plan

ARLINGTON HIGH SCHOOL
CONSTRUCTION PERIOD POLLUTION PREVENTION PLAN AND EROSION CONTROL
OPERATION AND MAINTENANCE PLAN
MAY 2020

During The Construction Period the General Contractor shall be responsible for the following:

1. Erosion Control

Erosion control barriers will be placed along down-gradient portion of the site as indicated on the project plans. Additional erosion control barriers will be placed at the limit of work as needed and in any sensitive areas as work progresses.

A stockpile of additional erosion control barriers shall be kept on site at all times

2. Site Access

Site access, for construction equipment will be from Massachusetts Ave. and Mill Brook Drive via an existing access drive as shown on the phased Demolition and Soil Erosion Plans, and all construction entrances will be installed at the onset of the project.

3. Construction Staging

A construction staging area will be established by the Contractor.

4. Site Grading/Site Work

The site activities may only commence when the site is stable from erosion and all required control measures are in place and functional.

5. Slope Stabilization

All surfaces and slopes shall be checked at least once every 7 calendar days and within 24 hours of the occurrence of a storm event 0.25 inches or greater to see that vegetation is in good condition. Any rills or damage from erosion shall be repaired immediately to avoid further damage. If seeps develop on the slopes, the area will be evaluated to determine if the seep will cause an unstable condition and shall be stabilized immediately if necessary. Problems found during the inspections by the General Contractor shall be repaired promptly. Areas requiring re-vegetation shall be replanted immediately or stabilized in a manner acceptable to the Conservation Commission if it is outside of the growing season. Slopes and other exposed surfaces receiving vegetation will be maintained as necessary to support healthy vegetation. If stabilization is required during the non-growing season, straw mulch, or a commercially manufactured blanket must be employed to prevent erosion.

6. Permanent Stabilization

Disturbed portions of the site where construction activities permanently cease shall be stabilized with permanent seed no later than 14 days after the last construction activity. The permanent seed mix, fertilizer, and mulch shall be specified on the project plans. Permanent seeding shall occur in the Spring or Fall.

7. Drainage Structures (Catch Basins, Area Drains, Manholes, WQU's)

All structures shall be inspected on a bi-weekly basis and/or after every rain storm and repairs made as necessary. Sediment shall be removed from the sump after the sediment has reached a maximum of one half the depth of the sump. The sediment shall be removed from the site and properly disposed of. Drainage structures/sumps shall be cleaned completely at the end of construction.

8. Dust and Sediment Control

Siltsacks:
Catch basin/Area drain filters shall be placed at all inlets to drainage structures as structures are installed and prior to pavement removal. Outlet protection work shall be constructed before runoff is allowed to enter the drainage system. Construction and location of catch basin filters shall be as indicated on the Drawings.

Straw Wattles:
Straw bales shall be installed as indicated on the Drawings.

Bales shall be placed in a row with ends tightly abutting the adjacent wattles. Each roll shall be securely anchored in place by 2 stakes or re-bars driven through the wattles. The first stake in each roll shall be angled toward the previously laid straw wattle to force them together.

Construction Entrance:
The area of the construction entrance should be cleared of all vegetation, roots, and other objectionable material. The filter fabric should be placed on the subgrade prior to the gravel placement. The gravel shall be placed to the specified dimensions depicted on the plans.

The Construction entrance shall be a minimum of 50-feet in length and 20-feet wide.

Dust Control:
A mechanical street sweeper shall be utilized to clean the existing paved areas on an as-needed basis.

For emergency control of dust apply water to affected areas. The source of supply and the method of application for water are the responsibility of the contractor.

Pollution Prevention Measures

1. Before, during, and after construction, functional erosion and sedimentation controls shall be implemented to prevent the silting of the wetland areas down-gradient of the site. Straw bales, crushed stone, temporary stabilization and other controls shall be properly maintained and are not to be removed until the site is permanently stabilized. Other controls shall be added as warranted during construction to protect environmentally-sensitive areas. Sufficient extra materials (e.g. straw bales and other control materials) shall be stored on site for emergencies.

2. Silt sacks and straw bale check dams shall be installed at all existing and proposed infiltration areas to protect from soils and sediment.

3. Casting of excavated materials shall be stored away from wetland areas and sensitive land areas.

4. Any stockpiling of loose materials shall be properly stabilized to prevent erosion and siltation. Preventative controls such as straw wattles, temporary seeding/mulching and jute covering shall be implemented to prevent such an occurrence.

5. There shall be no flooding, ponding, or flood related damage caused by the project or surface run-off emanating from the project on lands of an abutter, nearby or down-gradient of the site.

6. There shall be no contaminant migration caused by the project to nearby and down-gradient properties, nearby aquifers, and nearby resource areas.

7. The contractor shall make sufficient provisions to control any unexpected drainage and erosion conditions that may arise during construction that may create damage on abutting properties. Said control measures are to be implemented at once.

8. During construction flood prevention, erosion, and sedimentation controls shall be in place before the natural ground cover is disturbed. Said controls shall be in place prior to other construction work and shall be monitored and approved by the Contractor. They shall be properly maintained and are not to be removed until the site is stabilized.

9. The Contractor shall designate a person or persons to inspect and supervise the erosion controls for the project. The Conservation Commission shall be notified as to the means to contact said individual or individuals on a 24-hour basis on all working and non-working days of the project. Said means of contact shall include at least 2 separate telephone number of said designated person or persons.

10. There shall be periodic inspection of straw wattles, and other erosion controls by the Contractor's Designee to assure their continued effectiveness.

11. The Contractor shall make adequate provisions for controlling erosion and sediment from activities that might yield water at high volumes with high suspended solid contents, such as dewatering excavations.

12. Street sweeping shall be used to keep public ways free and clear of sediment and dirt from the site activities.

Other Control Measures

Waste Materials. All trash and construction debris from the site will be hauled to an approved landfill or recycling facility. No construction waste material will be buried on the site. All personnel will receive instructions regarding the correct procedure for waste disposal. Notices describing these practices will be posted in the construction office. The site superintendent will be responsible for seeing that these procedures are followed. Employee waste and other loose materials will be collected so as to prevent the release of floatables during rainfall events.

Hazardous Waste. No Hazardous materials are expected to be encountered. The mandated State and Local permits for removal of such materials, if located, will be implemented when such materials are encountered.

After Construction, the owner shall be responsible for the following:

General Land Grading and Slopes Stabilization

All surfaces and slopes shall be checked bi-annually to see that vegetation is in good condition. Any rills or damage from erosion shall be repaired immediately to avoid further damage. If seeps develop on the slopes, the area will be evaluated to determine if the seep will cause an unstable condition and shall be stabilized immediately if necessary. Problems found during the inspections by the Owner shall be repaired promptly. Areas requiring re-vegetation shall be replanted immediately. Slopes and other exposed surfaces receiving vegetation will be maintained as necessary to support healthy vegetation.

Areas of steep slopes (2.5:1 or greater) shall be stabilized using jute mesh or a similar approved erosion blanket.

Erosion Controls

Erosion controls shall not be removed or dismantled without approval from the Engineer or Conservation Commission. Sediment deposits that are removed or left in place after the barriers have been dismantled shall be graded manually to conform to the existing topography and vegetated using seeding or other long term cover as approved in the Landscape Plan. Bare ground that cannot be permanently stabilized within 30 days shall be stabilized by temporary measures.

Street Sweeping ($500 per sweeping)

It is proposed that the parking and drive areas be swept with a wet brush street sweeper on a semi-annual basis, with at least two sweepings per year. One sweep shall be done at the end of the winter season (prior to the heavy rains), and the other sweep at the end of autumn (prior to snowfall).

Stormwater Management System

Catch Basins, Area Drains, and Drain Manholes ($500 per CB structure per inspection/cleaning):
The catch basins, drain manholes, WQU's, infiltration systems, and area drains shall be inspected semi-annually, and cleaned out when sumps are approximately one foot full. The use of "clam shells" for sediment removal shall not be allowed; a vacuum truck shall be the approved method of cleaning. Integrity and functionality of oil hoods shall also be checked at the time of the inspection.

Water Quality Unit (WQU) ($1000 per structure per inspection/cleaning):
Water Quality Unit shall be as follows and per manufacturer's recommendations:

- Units should be inspected post-construction, prior to being put into service.
- Inspect every six months for the first year of operation to determine the oil and sediment accumulation rate. In subsequent years, inspections can be based on first-year observations
- Cleaning is required once the sediment depth reaches 15% of storage capacity, (generally taking one year or longer).
- Inspect the unit immediately after an oil, fuel or chemical spill.
- A licensed waste management company should remove captured petroleum waste products from any oil, chemical or fuel spills and dispose responsibly

Rain Garden ($750 per cleaning):
Inspection and Maintenance of Rain Gardens shall be conducted per the Bioretention Maintenance Schedule provided below from the Massachusetts Stormwater Handbook:

Bioretention Maintenance Schedule		
Activity	***Time of Year***	***Frequency***
Inspect & remove trash	Year round	Monthly
Mulch	Spring	Annually
Remove dead vegetation	Fall or Spring	Annually
Replace dead vegetation	Spring	Annually
Prune	Spring or Fall	Annually
Replace entire media & all vegetation	Late Spring/early Summer	As needed*

** Paying careful attention to pretreatment and operation & maintenance can extend the life of the soil media*

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Infiltration System ($2,500 per cleaning; $1,000 per inspection)

The proposed infiltration system shall be inspected semi-annually, and shall follow the suggested schedule for routine maintenance during the regular operation of the stormwater system:

Inlets and Outlets	Every 3 years	• Obtain documentation that the inlets, outlets and vents have been cleaned and will function as intended.
	Spring and Fall	• Check inlet and outlets for clogging and remove any debris as required.
Stormwater Chambers	2 years after commissioning	• Inspect the interior of the stormwater management chambers through inspection port for deficiencies using CCTV or comparable technique. • Obtain documentation that the stormwater management chambers and feed connectors will function as anticipated.
	9 years after commissioning every 9 years following	• Clean stormwater management chambers and feed connectors of any debris. • Inspect the interior of the stormwater management structures for deficiencies using CCTV or comparable technique. • Obtain documentation that the stormwater management chambers and feed connectors have been cleaned and will function as intended.
	45 years after commissioning	• Clean stormwater management chambers and feed connectors of any debris. • Determine the remaining life expectancy of the stormwater management chambers and recommended schedule and actions to rehabilitate the stormwater management chambers as required. • Inspect the interior of the stormwater management chambers for deficiencies using CCTV or comparable technique. • Replace or restore the stormwater management chambers in accordance with the schedule determined at the 45-year inspection. • Attain the appropriate approvals as required. • Establish a new operation and maintenance schedule.
Surrounding Site	Monthly in 1st year	• Check for depressions in areas over and surrounding the stormwater management system.
	Spring and Fall	• Check for depressions in areas over and surrounding the stormwater management system.
	Yearly	• Confirm that no unauthorized modifications have been performed to the site.

Maintenance and Emergency Repairs

Any maintenance or emergency repairs to the system will be the responsibility of the Owner.

INSPECTION REPORT FORM FOR STORM WATER SYSTEM

Project: Arlington High School, Arlington, MA
869 Massachusetts Avenue, Arlington, MA 02476

INSPECTOR:________________________________**DATE:**______________________________

Regular Inspection: ☐
Inspection after Rainfall: ☐ **Amount of Rainfall:**______**inches**

BMP	Functioning Correctly	Notes/Action Taken
	Y/N	
	Y/N	
	Y/N	
	Y/N	
	Y/N	
	Y/N	
	Y/N	

Additional Observations: ____

____

____

Action Required: ____

____

____

To be performed by:________________________________**On or Before:**________________

APPENDIX 5:
Calculations

STORM DRAIN COMPUTATION SHEET

5/7/2020

Section 1: Direct Inlet "Branch" Segments (Area Drains, Catch Basins, etc.)

SEGMENT			WATERSHED CHARACTERISTICS					PIPE CHARACTERISTICS				MANNING'S VALUES					
			Design Frequency		25-year							Pipe Design Depth			1.00 D		
No.	Start	End	Drain. Area	Runoff Coeff.	Time of Conc.	Rainfall Intens.	Q (min) CiA	Pipe Diameter D	Pipe Material	Pipe Length	Pipe Slope	n	A	R	Q (max)	Head above invert	Velocity
			acres		min	in/hr	cfs	in		ft			sf	ft		ft	fps
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
1	CB1	DMH1	0.123	0.95	6.0	5.90	**0.70**	12	HDPE	177	0.015	0.011	0.785	0.250	**5.17**	-	0.0 fps
2	CB2	DMH1	0.117	0.95	6.0	5.90	**0.66**	12	HDPE	6	0.010	0.011	0.785	0.250	**4.22**	-	3.6 fps
3	CB3	DMH12	0.443	0.58	6.0	5.90	**1.54**	12	HDPE	171	0.005	0.011	0.785	0.250	**2.99**	-	4.0 fps
4	CB4	RG2	0.372	0.95	6.0	5.90	**2.31**	12	HDPE	128	0.050	0.011	0.785	0.250	**9.44**	-	9.4 fps
5	CB5	DMH3	0.474	0.90	6.0	5.90	**2.53**	12	HDPE	183	0.050	0.010	0.785	0.250	**10.38**	-	11.5 fps
6	CB6	DMH11	0.305	0.80	6.0	5.90	**1.45**	12	HDPE	52	0.042	0.011	0.785	0.250	**8.65**	-	7.7 fps
7	CB7	DMH11	0.641	0.94	6.0	5.90	**3.57**	12	HDPE	60	0.009	0.011	0.785	0.250	**4.01**	-	5.1 fps
8	CB8	WQU1	0.200	0.95	6.0	5.90	**1.13**	12	HDPE	11	0.020	0.011	0.785	0.250	**5.97**	-	7.6 fps
9	CB9	WQU1	0.157	0.80	6.0	5.90	**0.74**	12	HDPE	76	0.010	0.011	0.785	0.250	**4.22**	-	5.4 fps
10	CB10	DMH3	0.502	0.86	6.0	5.90	**2.57**	12	HDPE	21	0.030	0.011	0.785	0.250	**7.31**	-	9.3 fps
11	CB11	DMH5	0.727	0.57	6.0	5.90	**2.49**	12	HDPE	47	0.010	0.011	0.785	0.250	**4.22**	-	5.4 fps
12	CB12	DMH7	1.070	0.70	6.0	5.90	**4.43**	12	HDPE	46	0.020	0.011	0.785	0.250	**5.97**	-	7.6 fps
13	CB13	MILL BRK	0.309	0.84	6.0	5.90	**1.55**	12	HDPE	45	0.030	0.011	0.785	0.250	**7.31**	-	9.3 fps
14	TD-2	DMH2	0.237	0.92	6.0	5.90	**1.29**	12	HDPE	107	0.010	0.011	0.785	0.250	**4.22**	-	5.4 fps
15	AD-3	DMH1	0.101	0.42	6.0	5.90	**0.25**	8	HDPE	48	0.005	0.011	0.349	0.167	**1.01**	-	2.9 fps
16	AD-5	DMH14	0.034	0.95	6.0	5.90	**0.19**	8	HDPE	20	0.100	0.011	0.349	0.167	**4.53**	-	13.0 fps
17	AD-6	DMH4	0.046	0.52	6.0	5.90	**0.14**	8	HDPE	5	0.010	0.011	0.349	0.167	**1.43**	-	4.1 fps
18	AD-7	DMH5	0.023	0.25	6.0	5.90	**0.03**	8	HDPE	12	0.010	0.011	0.349	0.167	**1.43**	-	4.1 fps
19	RD-1	DMH13	0.656	0.95	6.0	5.90	**3.71**	12	HDPE	150	0.010	0.011	0.785	0.250	**4.22**	-	5.4 fps
20	RD-2	DMH13	0.576	0.95	6.0	5.90	**3.25**	12	HDPE	14	0.025	0.011	0.785	0.250	**6.68**	-	8.5 fps
21	RD-3	DMH8	0.232	0.95	6.0	5.90	**1.31**	10	HDPE	20	0.030	0.011	0.545	0.208	**4.50**	-	8.2 fps
22	RD-4	DMH6	0.862	0.95	6.0	5.90	**4.87**	12	HDPE	52	0.020	0.011	0.785	0.250	**5.97**	-	7.6 fps
23	RD-5	DMH5	0.709	0.95	6.0	5.90	**4.01**	12	HDPE	49	0.010	0.011	0.785	0.250	**4.22**	-	5.4 fps
24	RD-6	DMH4	0.333	0.95	6.0	5.90	**1.88**	12	HDPE	8	0.010	0.011	0.785	0.250	**4.22**	-	5.4 fps
25	RD-7	DMH14	0.186	0.95	6.0	5.90	**1.05**	12	HDPE	7	0.010	0.011	0.785	0.250	**4.22**	-	5.4 fps
26	AD15	DMH3	0.307	0.22	6.0	5.90	**0.40**	6	PVC	106	0.015	0.010	0.196	0.125	**0.90**	-	4.6 fps
27	AD10	DMH8	0.132	0.71	6.0	5.90	**0.56**	6	PVC	200	0.016	0.010	0.196	0.125	**0.93**	-	4.7 fps

STORM DRAIN COMPUTATION SHEET

Section 2: Main Line "Trunk" Segments (Drain Basins, Manholes, etc.)

SEGMENT			WATERSHED CHARACTERISTICS	PIPE CHARACTERISTICS				MANNING'S VALUES					
			Design Frequency 25-year					Pipe Design Depth			1.00 D		
No.	Start	End	Q (min)	Pipe Diameter	Pipe Material	Pipe Length	Pipe Slope	n	A	R	Q (max)	Head above invert	Velocity
1	DMH1	DMH2	**1.36**	12	HDPE	46	0.010	0.011	0.785	0.250	**4.22**	-	4.6 fps
2	DMH2	RG1	**2.65**	12	HDPE	99	0.050	0.011	0.785	0.250	**9.44**	-	9.7 fps
3	DMH14	DMH3	**1.24**	12	HDPE	33	0.010	0.011	0.785	0.250	**4.22**	-	4.4 fps
4	DMH3	DMH4	**10.18**	24	HDPE	81	0.005	0.011	3.142	0.500	**18.96**	-	6.2 fps
5	DMH4	DMH5	**12.20**	24	HDPE	90	0.005	0.011	3.142	0.500	**18.96**	-	6.5 fps
6	DMH5	DMH6	**21.10**	30	HDPE	108	0.005	0.011	4.909	0.625	**34.37**	-	7.5 fps
7	DMH6	DMH7	**25.97**	30	HDPE	74	0.005	0.011	4.909	0.625	**34.37**	-	7.0 fps
8	DMH7	DMH8	**30.39**	30	HDPE	115	0.005	0.011	4.909	0.625	**34.37**	-	7.0 fps
9	DMH8	DMH9	**32.27**	30	HDPE	90	0.005	0.011	4.909	0.625	**34.37**	-	7.0 fps
10	DMH11	DMH10	**5.02**	15	HDPE	20	0.005	0.011	1.227	0.313	**5.41**	-	4.4 fps
11	DMH10	UGS1	**6.57**	18	HDPE	4	0.005	0.011	1.767	0.375	**8.80**	-	5.6 fps
12	WQU1	MILL BRK	**1.87**	12	HDPE	11	0.020	0.011	0.785	0.250	**5.97**	-	7.6 fps
13	DMH13	DMH15	**6.96**	12	HDPE	62	0.030	0.011	0.785	0.250	**7.31**	-	9.3 fps
14	DMH15	DMH12	**6.96**	12	HDPE	47	0.240	0.011	0.785	0.250	**20.68**	-	26.3 fps
15	DMH12	DMH16	**6.96**	12	HDPE	82	0.130	0.011	0.785	0.250	**15.22**	-	19.4 fps
16	DMH16	DMH17	**6.96**	15	HDPE	70	0.027	0.011	1.227	0.313	**12.58**	-	10.2 fps
17	DMH17	DMH18	**6.96**	15	HDPE	80	0.025	0.011	1.227	0.313	**12.10**	-	9.9 fps

Stage-Area-Storage for Pond 1P: rain garden#1 cascading

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
58.50	150	0
58.55	150	3
58.60	150	6
58.65	150	9
58.70	150	12
58.75	150	15
58.80	150	18
58.85	150	21
58.90	150	24
58.95	150	27
59.00	150	30
59.05	150	32
59.10	150	34
59.15	150	36
59.20	150	38
59.25	150	39
59.30	150	41
59.35	150	43
59.40	150	45
59.45	150	47
59.50	150	49
59.55	150	51
59.60	150	53
59.65	150	54
59.70	150	56
59.75	150	58
59.80	150	60
59.85	150	62
59.90	150	64
59.95	150	66
60.00	150	68
60.05	150	69
60.10	150	71
60.15	150	73
60.20	150	75
60.25	150	77
60.30	150	79
60.35	150	80
60.40	150	82
60.45	150	83
60.50	150	85
60.55	159	93
60.60	167	101
60.65	176	109
60.70	184	118
60.75	193	128
60.80	202	138
60.85	210	148
60.90	219	159
60.95	227	170
61.00	236	181
61.05	249	194
61.10	263	206
61.15	276	220
61.20	289	234
61.25	303	249
61.30	316	264
61.35	329	280
61.40	343	297
61.45	356	315
61.50	370	333
61.55	383	352
61.60	396	371
61.65	410	391
61.70	423	412
61.75	436	434
61.80	450	456
61.85	463	479
61.90	476	502
61.95	490	526
62.00	503	551
62.05	511	576
62.10	519	602
62.15	527	628
62.20	534	655
62.25	542	682
62.30	550	709
62.35	558	737
62.40	566	765
62.45	574	793
62.50	582	822
62.55	589	851
62.60	597	881
62.65	605	911
62.70	613	942
62.75	621	972
62.80	629	1,004
62.85	636	1,035
62.90	644	1,067
62.95	652	1,100
63.00	**660**	**1,132**

STATIC STORAGE

Stage-Area-Storage for Pond 2P: rain garden#2 cascading

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
51.00	400	0
51.05	400	8
51.10	400	16
51.15	400	24
51.20	400	32
51.25	400	40
51.30	400	48
51.35	400	56
51.40	400	64
51.45	400	72
51.50	400	80
51.55	400	85
51.60	400	90
51.65	400	95
51.70	400	100
51.75	400	105
51.80	400	110
51.85	400	115
51.90	400	120
51.95	400	125
52.00	400	130
52.05	400	135
52.10	400	140
52.15	400	145
52.20	400	150
52.25	400	155
52.30	400	160
52.35	400	165
52.40	400	170
52.45	400	175
52.50	400	180
52.55	400	185
52.60	400	190
52.65	400	195
52.70	400	200
52.75	400	205
52.80	400	210
52.85	400	215
52.90	400	219
52.95	400	223
53.00	400	227
53.05	415	247
53.10	429	268
53.15	444	290
53.20	459	312
53.25	474	336
53.30	488	360
53.35	503	385
53.40	518	410
53.45	532	436
53.50	547	463
53.55	562	491

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
53.60	576	520
53.65	591	549
53.70	606	579
53.75	621	609
53.80	635	641
53.85	650	673
53.90	665	706
53.95	679	739
54.00	694	774
54.05	726	809
54.10	757	846
54.15	789	885
54.20	820	925
54.25	852	967
54.30	884	1,010
54.35	915	1,055
54.40	947	1,102
54.45	978	1,150
54.50	1,010	1,200
54.55	1,042	1,251
54.60	1,073	1,304
54.65	1,105	1,358
54.70	1,136	1,414
54.75	1,168	1,472
54.80	1,200	1,531
54.85	1,231	1,592
54.90	1,263	1,654
54.95	1,294	1,718
55.00	**1,326**	**1,784**

STATIC STORAGE

Stage-Area-Storage for Pond 3P: rain garden#3 cascading

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
46.00	600	0
46.05	600	12
46.10	600	24
46.15	600	36
46.20	600	48
46.25	600	60
46.30	600	72
46.35	600	84
46.40	600	96
46.45	600	108
46.50	600	120
46.55	600	127
46.60	600	135
46.65	600	142
46.70	600	150
46.75	600	158
46.80	600	165
46.85	600	173
46.90	600	180
46.95	600	188
47.00	600	195
47.05	600	202
47.10	600	210
47.15	600	217
47.20	600	225
47.25	600	233
47.30	600	240
47.35	600	248
47.40	600	255
47.45	600	263
47.50	600	270
47.55	600	277
47.60	600	285
47.65	600	292
47.70	600	300
47.75	600	308
47.80	600	315
47.85	600	322
47.90	600	328
47.95	600	334
48.00	600	340
48.05	618	370
48.10	636	402
48.15	654	434
48.20	671	467
48.25	689	501
48.30	707	536
48.35	725	572
48.40	743	608
48.45	761	646
48.50	779	685
48.55	796	724
48.60	814	764
48.65	832	805
48.70	850	847
48.75	868	890
48.80	886	934
48.85	903	979
48.90	921	1,024
48.95	939	1,071
49.00	957	1,118
49.05	978	1,167
49.10	999	1,216
49.15	1,019	1,267
49.20	1,040	1,318
49.25	1,061	1,371
49.30	1,082	1,424
49.35	1,103	1,479
49.40	1,123	1,534
49.45	1,144	1,591
49.50	1,165	1,649
49.55	1,186	1,708
49.60	1,207	1,767
49.65	1,227	1,828
49.70	1,248	1,890
49.75	1,269	1,953
49.80	1,290	2,017
49.85	1,311	2,082
49.90	1,331	2,148
49.95	1,352	2,215
50.00	**1,373**	**2,283**

STATIC STORAGE

Stage-Area-Storage for Pond 4P: UGS-1

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
39.50	**1,672**	0
39.60	1,672	59
39.70	1,672	117
39.80	1,672	176
39.90	1,672	234
40.00	1,672	293
40.10	1,672	351
40.20	1,672	410
40.30	1,672	508
40.40	1,672	645
40.50	1,672	783
40.60	1,672	919
40.70	1,672	1,055
40.80	1,672	1,190
40.90	1,672	1,325
41.00	1,672	1,459
41.10	1,672	1,592
41.20	1,672	1,724
41.30	1,672	1,855
41.40	1,672	1,986
41.50	1,672	2,116
41.60	1,672	2,244
41.70	1,672	2,372
41.80	1,672	2,498
41.90	1,672	2,623
42.00	1,672	2,747
42.10	1,672	2,870
42.20	1,672	2,991
42.30	1,672	3,110
42.40	1,672	3,228
42.50	1,672	3,344
42.60	1,672	3,458
42.70	1,672	3,570
42.80	1,672	3,680
42.90	1,672	3,788
43.00	1,672	3,893
43.10	1,672	3,995
43.20	1,672	4,094
43.30	1,672	4,190
43.40	1,672	4,282
43.50	1,672	4,369
43.60	1,672	4,449
43.70	1,672	4,522
43.80	1,672	4,588
43.90	1,672	4,652
44.00	1,672	4,712
44.10	1,672	4,771
44.20	1,672	4,829
44.30	1,672	4,888
44.40	1,672	4,946
44.50	1,672	5,005
44.60	1,672	5,063
44.70	1,672	5,122
44.80	1,672	5,180
44.90	1,672	5,239
45.00	1,672	**5,297**

STATIC STORAGE

ARLINGTON HIGH SCHOOL CULVERT RELOCATION

Existing Culvert:

In the existing condition there is a large culvert, consisting of a 36" reinforced concrete pipe (RCP), that flows under the existing building and discharges to the Mill Brook culvert. This culvert carries a large watershed from South of the project site which measures 4,626,374 sf (106.20 Ac). Historically this culvert has been shown to be undersized and has caused flooding and foloor buckling within the basement of the high school and will be relocated and improved under post construction conditions while keeping the flow rates equal to the existing flow rates so that the stormwater doesn't impact areas downstream.

Results/ Summary

Through the use of the rational method to anticpate pipe discharge rates, both the existing and proposed culvert were modeled to show flows for the 25 year storm event.

The watershed that contributes to the culvert is large and holds approximately 40.36 acres,as shown in the chart entitled WATERSHED DRAINAGE CALCULATIONS below.

WATERSHED DRAINAGE CALCULATIONS												
LOCATION		IMPERVIOUS AREA			OTHER			SUM		I	Q	
FROM	TO	A (Ac)	C	CA	A (Ac)	C	CA	CA	Tc	(in/hr)	IxCA	DESIGN PERIOD 25-YEAR
Watershed	Culvert	40.36	0.9	36.32	65.85	0.3	19.76	56.08	11.6	6.0	336.47	

As shown in Table 1, the post development flows are similar to the pre-development flows so that the new culvert will not have an adverse effect to downstream areas.

Existing Culvert 36" RCP															
Ex. MH	Pipe Bend	40.36	0.9	36.32	65.85	0.3	19.76	56.08	11.6	6.0	336.47	36	RCP	0.005	0.013	47.16
Pipe Bend	Ex. MH 1	40.36	0.9	36.32	65.85	0.3	19.76	56.08	11.6	6.0	336.47	36	RCP	0.160	0.013	266.79
	Site Area 1	0.47	0.9	0.42	1.07	0.3	0.32	0.74	11.6	6.0						
Ex. MH 1	Ex. MH 2	40.83	0.9	36.75	66.92	0.3	20.08	56.82	11.6	6.0	340.94	36	RCP	0.052	0.013	152.10
Ex. MH 2	Ex. MH 3	40.83	0.9	36.75	66.92	0.3	20.08	56.82	11.6	6.0	340.94	36	RCP	0.013	0.013	77.21
	Site Area 2	0.56	0.9	0.50	0.74	0.3	0.22	0.73	11.6	6.0						
Ex. MH 3	Ex. MH 4	41.39	0.9	37.25	67.66	0.3	20.30	57.55	11.6	6.0	345.29	36	RCP	0.014	0.013	78.64
	Site Area 3	0.67	0.9	0.60	0.18	0.3	0.05	0.66	11.6	6.0						
Ex. MH 4	Ex. culvert	42.06	0.9	37.85	67.84	0.3	20.35	58.21	11.6	6.0	349.24	36	RCP	0.005	0.013	47.16
Proposed Culvert - 48" / 36" CLDI Blended Option																
Ex. MH	DS-1	40.36	0.9	36.32	65.85	0.3	19.76	56.08	11.6	6.0	336.47	36	RCP	0.005	0.013	47.16
DS-1	ACC PT 1	40.36	0.9	36.32	65.85	0.3	19.76	56.08	11.6	6.0	336.47	48	DI	0.033	0.010	336.64
ACC PT 1	ACC PT 2	40.36	0.9	36.32	65.85	0.3	19.76	56.08	11.6	6.0	336.47	36	DI	0.075	0.010	237.46
ACC PT 2	ACC PT 3	40.36	0.9	36.32	65.85	0.3	19.76	56.08	11.6	6.0	336.47	36	DI	0.033	0.010	156.31
ACC PT 3	DS-2	40.36	0.9	36.32	65.85	0.3	19.76	56.08	11.6	6.0	336.47	36	DI	0.008	0.010	77.55
DS-2	Ex. culvert	40.36	0.9	36.32	65.85	0.3	19.76	56.08	11.6	6.0	336.47	36	RCP	0.005	0.013	47.16

APPENDIX 6:
Sketches

HMFH ARCHITECTS

Samiotes Consultants Inc.

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PROGRESS SET 05-04-2020

Arlington High School
Massachusetts Avenue, Arlington, Massachusetts
EXISTING CONDITIONS
HYDROLOGY MAP

REVISIONS NO.	DATE	REMARKS	BY

DRAWING NUMBER
EX-HYD

HMFH

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F 508.877.8349
www.samiotes.com

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PROGRESS SET 05-04-2020

REVISIONS NO.	DATE	REMARKS	BY

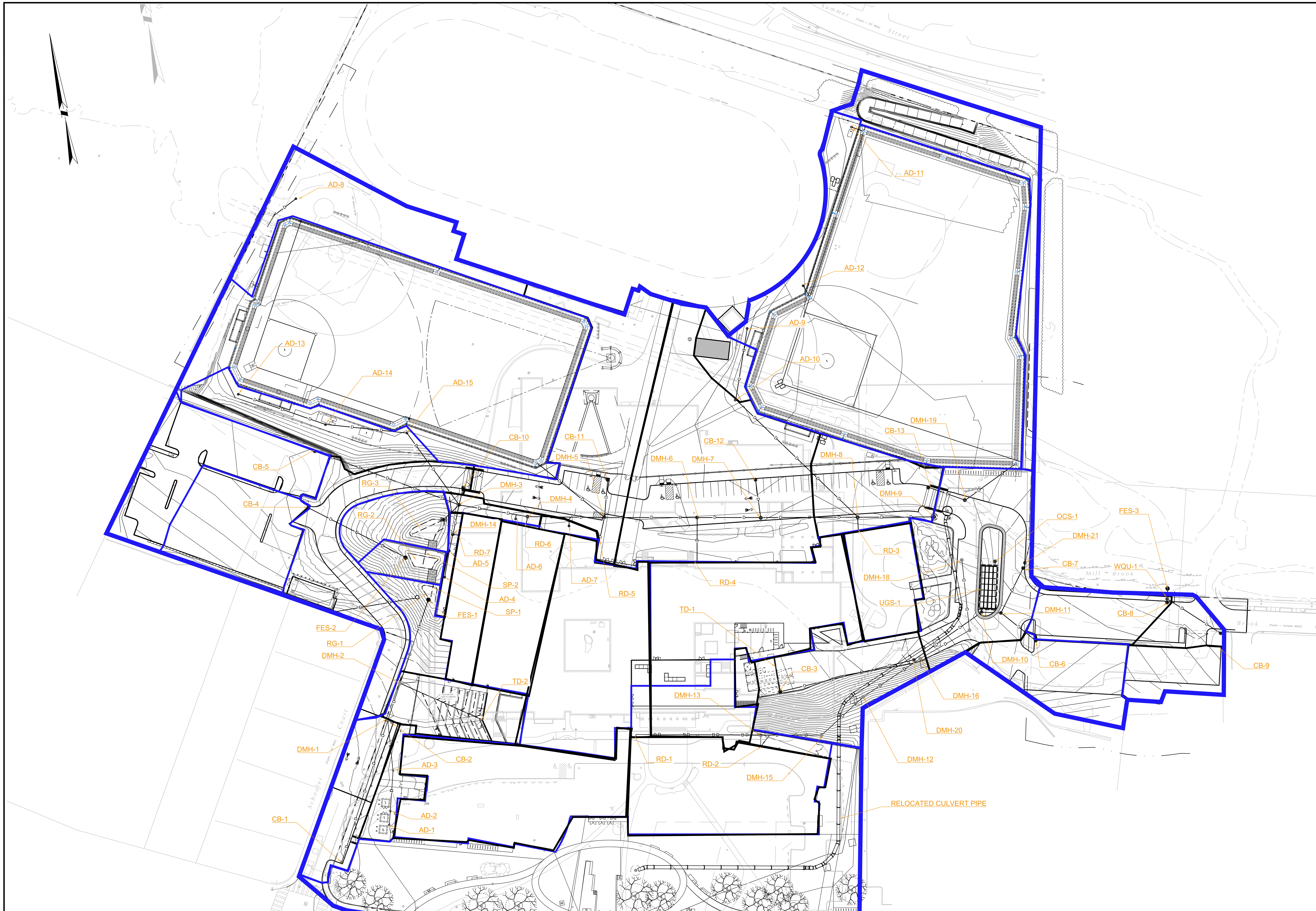
Arlington High School
Massachusetts Avenue, Arlington, Massachusetts

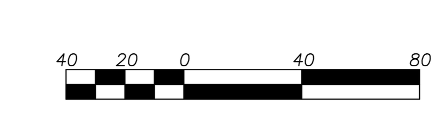
PROPOSED CONDITIONS HYDROLOGY MAP

SCALE:
DRAWN BY: SM
CHECKED BY: SG

DRAWING NUMBER
P-HYD

JOB NUMBER 17211





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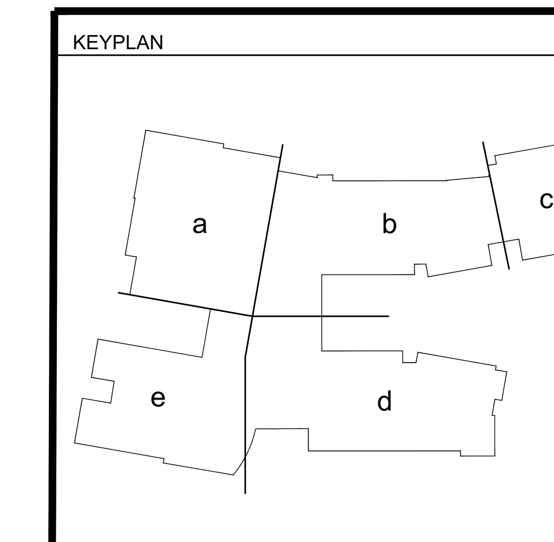
PROGRESS SET 05-04-2020

KEYPLAN



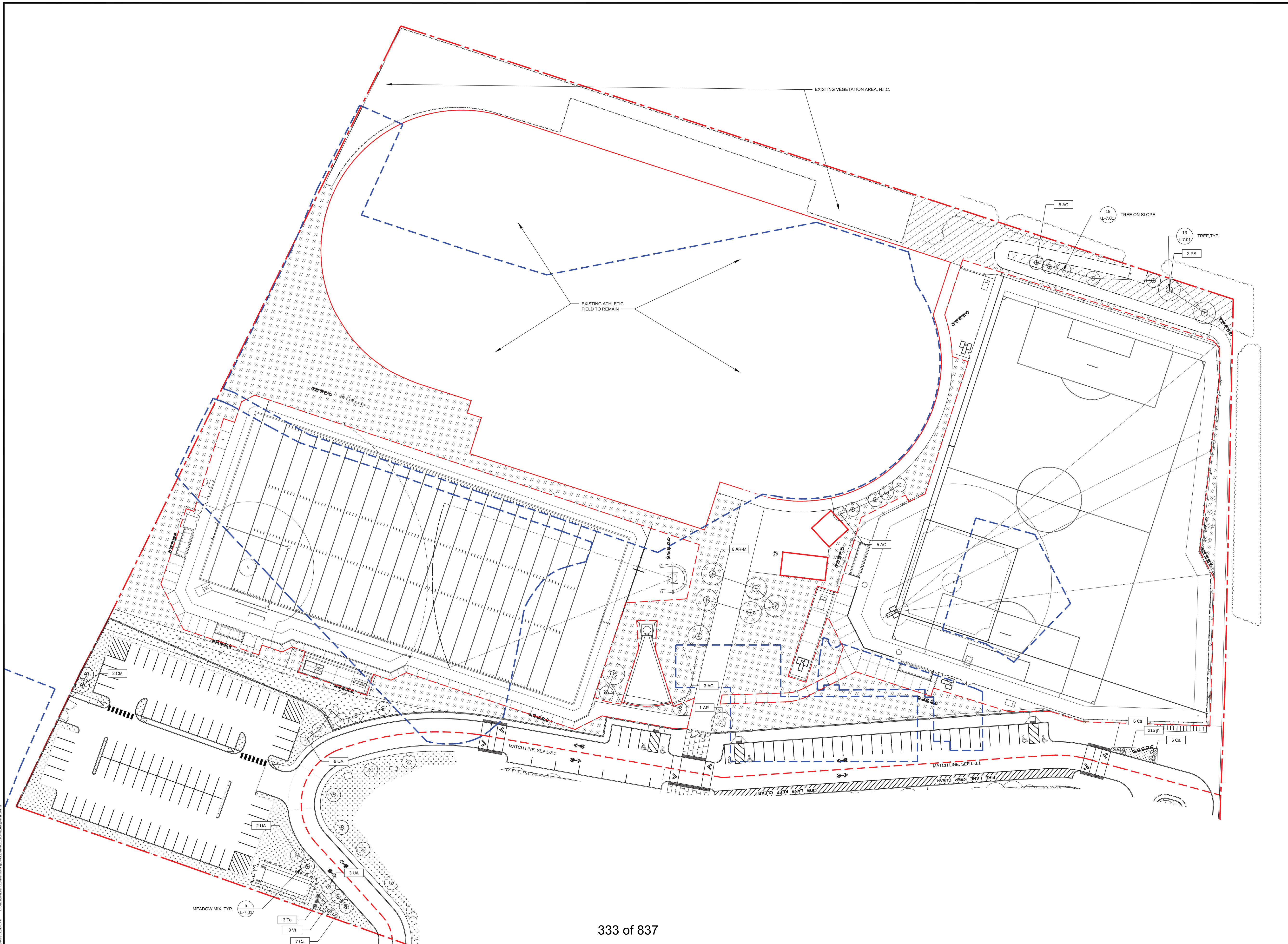
Arlington High School
Massachusetts Avenue, Arlington, Massachusetts
BMP LOCATION MAP

SCALE:
DRAWN BY: SM
CHECKED BY: SG

REVISIONS NO.	DATE	REMARKS	BY

DRAWING NUMBER
BMP

JOB NUMBER 17211



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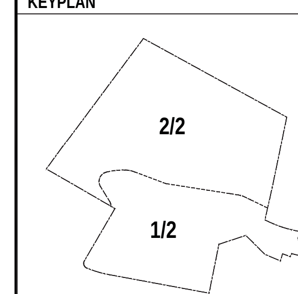

REVISIONS NO. | DATE | REMARKS | BY

HMFH ARCHITECTS

CSS Crosby Schlessinger Smallridge Landscape Architecture | Planning | Urban Design
67 Batterymarch Street 2nd Floor Boston, MA 02110

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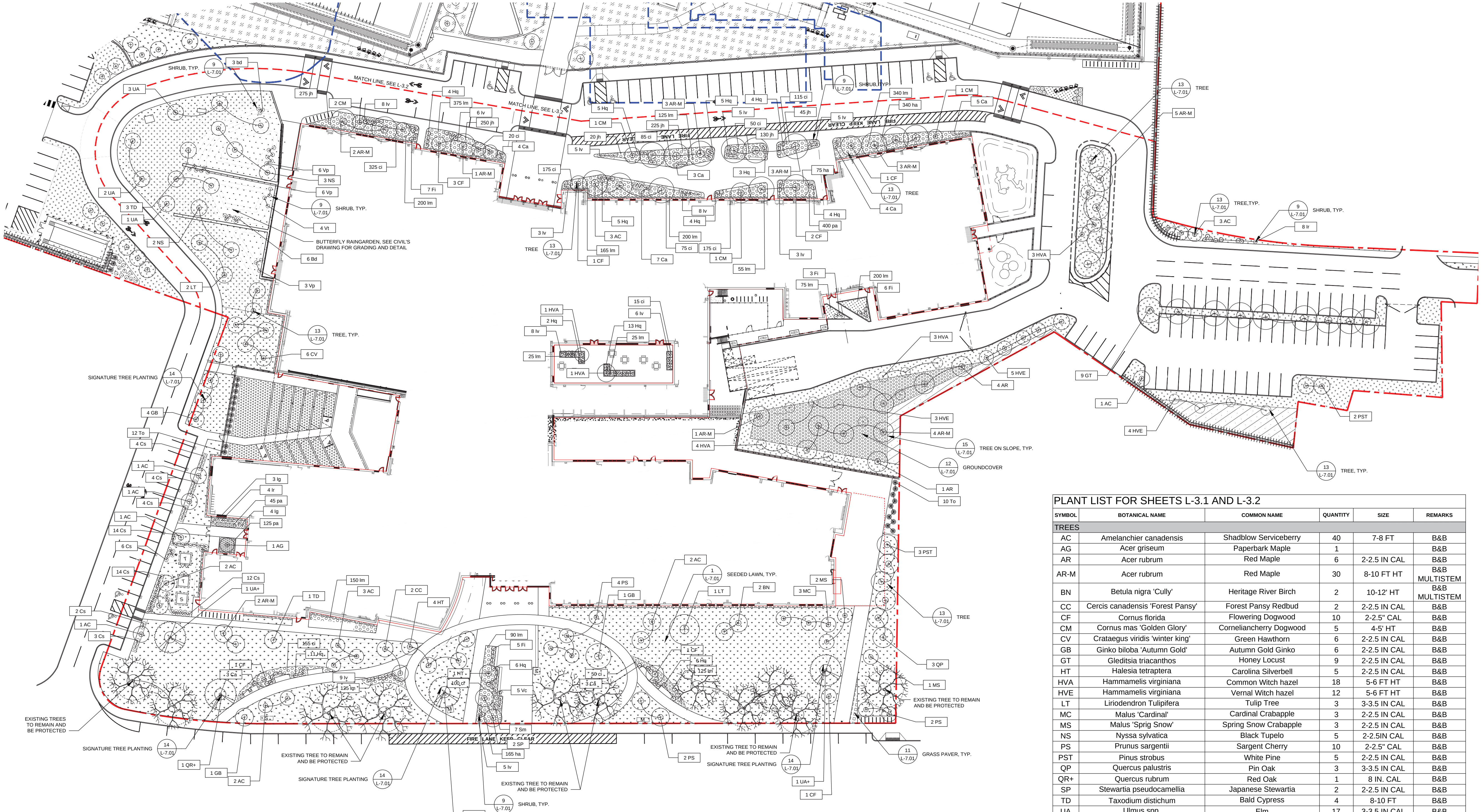
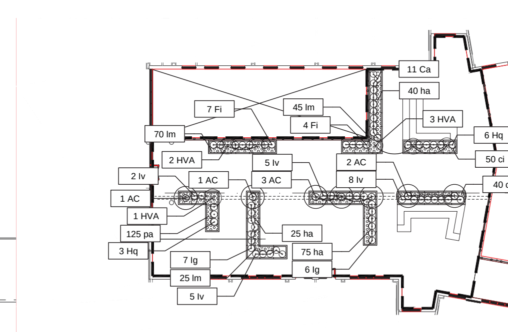
05-14-2020

Arlington High School
Massachusetts Avenue, Arlington, Massachusetts
LANDSCAPE PLANTING PLAN 2

SCALE: 1"=30'-0"
DRAWN BY:
CHECKED BY:

DRAWING NUMBER
L-3.2



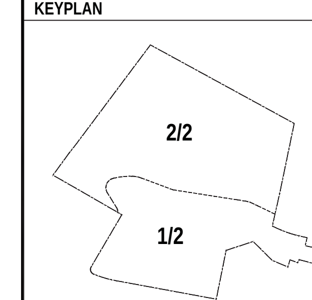


ROOF COURTYARD PLANTING PLAN

PLANT LIST FOR SHEETS L-3.1 AND L-3.2

SYMBOL	BOTANICAL NAME	COMMON NAME	QUANTITY	SIZE	REMARKS
TREES					
AC	Amelanchier canadensis	Shadblow Serviceberry	40	7-8 FT	B&B
AG	Acer griseum	Paperbark Maple	1		B&B
AR	Acer rubrum	Red Maple	6	2-2.5 IN CAL	B&B
AR-M	Acer rubrum	Red Maple	30	8-10 FT HT	B&B MULTISTEM
BN	Betula nigra 'Cully'	Heritage River Birch	2	10-12' HT	B&B MULTISTEM
CC	Cercis canadensis 'Forest Pansy'	Forest Pansy Redbud	2	2-2.5 IN CAL	B&B
CF	Cornus florida	Flowering Dogwood	10	2-2.5" CAL	B&B
CM	Cornus mas 'Golden Glory'	Corneliancherry Dogwood	5	4-5' HT	B&B
CV	Crataegus viridis 'winter king'	Green Hawthorn	6	2-2.5 IN CAL	B&B
GB	Ginko biloba 'Autumn Gold'	Autumn Gold Ginko	6	2-2.5 IN CAL	B&B
GT	Gleditsia triacanthos	Honey Locust	9	2-2.5 IN CAL	B&B
HT	Halesia tetraptera	Carolina Silverbell	5	2-2.5 IN CAL	B&B
HVA	Hammamelis virginiana	Common Witch hazel	18	5-6 FT HT	B&B
HVE	Hammamelis virginiana	Vernal Witch hazel	12	5-6 FT HT	B&B
LT	Liriodendron Tulipifera	Tulip Tree	3	3-3.5 IN CAL	B&B
MC	Malus 'Cardinal'	Cardinal Crabapple	3	2-2.5 IN CAL	B&B
MS	Malus 'Sprig Snow'	Spring Snow Crabapple	3	2-2.5 IN CAL	B&B
NS	Nyssa sylvatica	Black Tupelo	5	2-2.5IN CAL	B&B
PS	Prunus sargentii	Sargent Cherry	10	2-2.5" CAL	B&B
PST	Pinus strobus	White Pine	5	2-2.5 IN CAL	B&B
QP	Quercus palustris	Pin Oak	3	3-3.5 IN CAL	B&B
QR+	Quercus rubrum	Red Oak	1	8 IN. CAL	B&B
SP	Stewartia pseudocamellia	Japanese Stewartia	2	2-2.5 IN CAL	B&B
TD	Taxodium distichum	Bald Cypress	4	8-10 FT	B&B
UA	Ulmus spp.	Elm	17	3-3.5 IN CAL	B&B
UA+	Ulmus spp.	Elm	3	8 IN. CAL	B&B
SHRUBS					
Bd	Buddleja davidii	Butterfly bush	9	3 GAL	CONTAINER
Ca	Clethra alnifolia 'Ruby Spice'	Ruby Spice Summersweet	53	3 GAL	CONTAINER
Cs	Cornus sericea 'Alleman's'	Compact Red Twig Dogwood	63	5 GAL	CONTAINER
Fi	Fothergilla x intermedia 'Blue Shadow'	Blue Shadow Fothergilla	32	5 GAL	CONTAINER
Hq	Hydrangea quercifolia 'Pee Wee'	Pee Wee Oakleaf Hydrangea	81	3 GAL	CONTAINER
Ig	Ilex glabra 'Densa'	Densa Inkberry	20	5 GAL	CONTAINER
Ir	Ilex verticillata 'Red Sprite'	Red Sprite Winterberry	12	5 GAL	CONTAINER
Iv	Itea virginica 'Little Henry'	Little Henry Sweetspire	91	3 GAL	CONTAINER
Sm	Syringa meyeri 'Palibin'	Dwarf Meyer's Lilac	7	5 GAL	CONTAINER
To	Thuja occidentalis	Arborvitae	25	7-8 FT HT	B&B
Vc	Viburnum carlesii 'Compactum'	Dwarf Korean Spice Viburnum	5	5 GAL	CONTAINER
Vp	Viburnum plicatum tom. 'Mariesii'	Mariesi Double Fire Viburnum	15	3 GAL	CONTAINER
Vt	Viburnum trilobum	American cranberry bush	7	3 GAL	CONTAINER
PERENNIALS					
ci	Carex morrowii 'Ice Dance'	Ice Dance Japanese Sedge	1430	1 GAL	CONTAINER
ha	Hakonechloa macra 'All Gold'	All Gold Forest Grass	720	1 GAL	CONTAINER
jh	Juniperus horizontalis 'Wiltoni'	Blue Rug Creeping Juniper	1160	1 GAL	CONTAINER
lm	Liripe muscari 'Big Blue'	Big Blue Lily Turf	2390	1 GAL	CONTAINER
pa	Pachysandra	Pachysandra	695	4" POT	CONTAINER

KEYPLAN



HMFH ARCHITECTS

CROSBY SCHLESSINGER SMALLRIDGE
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Boston, MA 02110

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05-14-2020

Arlington High School
Massachusetts Avenue, Arlington, Massachusetts
LANDSCAPE PLANTING PLAN 1

SCALE: 1"=30'-0"

REVISIONS NO.	DATE	REMARKS	BY

DRAWING NUMBER
L-3.1

Construction Stormwater Pollution Prevention Plan Template

To be covered under the U.S. Environmental Protection Agency's (EPA) Construction General Permit (CGP), all construction operators are required to develop a "Stormwater Pollution Prevention Plan" (or "SWPPP") prior to submitting a Notice of Intent (NOI) for permit coverage. EPA created this SWPPP Template to help you develop a SWPPP that is compliant with the minimum requirements of Part 7 of EPA's 2017 Construction General Permit ("2017 CGP"), and is customizable to your specific project and site.

Instructions for Using the SWPPP Template

Each section of the SWPPP Template includes instructions and space for your project and site information. Read the instructions for each section before you complete that section. Specific instructions on what information to include is indicated in each text field in blue text. Click on the blue text and the instructions will disappear once you start typing. The SWPPP Template is an editable document file so that you can easily add tables and additional text, and delete unneeded or non-applicable fields. Note that some sections may require only a brief description while others may require several pages of explanation.

The following tips for using this template will help ensure that you meet the minimum permit requirements:

- Read the 2017 CGP thoroughly before you begin preparation of your SWPPP to ensure that you have a working understanding of the permit's underlying requirements. You will also need to consult Part 9 of the permit to determine if your state or tribe has included additional requirements that affect you.
- Complete the SWPPP prior to submitting your Notice of Intent (NOI) for permit coverage. This is required in Parts 1.4 and 7.1.
- If you prepared a SWPPP under a previous version of EPA's CGP, you must update your SWPPP to ensure that the 2017 CGP requirements are addressed prior to submitting your NOI.
- If there is more than one construction operator for your project, consider coordinating development of your SWPPP with the other operators.
- Once EPA has provided you coverage under the CGP, include your NOI, your authorization email, and a copy of the CGP as attachments to the SWPPP. See Appendices B and C of the SWPPP Template.

While EPA has made every effort to ensure the accuracy of all instructions contained in the SWPPP Template, it is the permit, not the template, that determines the actual obligations of regulated construction stormwater discharges. In the event of a conflict between the SWPPP Template and any corresponding provision of the 2017 CGP, you must abide by the requirements in the permit. EPA welcomes comments on the SWPPP Template at any time and will consider those comments in any future revision of this document. You may contact EPA for CGP-related inquiries at cgp@epa.gov.

Stormwater Pollution Prevention Plan (SWPPP)

For Construction Activities At:

Arlington High School
869 Massachusetts Ave
Arlington, Ma 02476
(781)316-3594

SWPPP Prepared For:

Town of Arlington
730 Massachusetts Ave
Arlington, Ma 02476
(781)316-3000

SWPPP Prepared By:

Samiotes Consultants, Inc.
Stephan Garvin, P.E.
20 A Street
Framingham, MA 01701
(508) 877-6688 ext. #13
Sgarvin@samiotes.com

SWPPP Preparation Date:

04/15/2020

Estimated Project Dates:

Project Start Date: 04/15/2020

Project Completion Date: 06/27/2025

Contents

SECTION 1: CONTACT INFORMATION/RESPONSIBLE PARTIES

1.1 Operator(s) / Subcontractor(s)

Operator(s):

Consigli Construction Company
72 Sumner St
Milford MA 01757

John LaMarre
617-293-5296
jlamarre@consigli.com

Subcontractor(s):

TBD

Emergency 24-Hour Contact:

Chuck McWilliams
Senior Superintendent
508-962-2237
cmcwilliams@consigli.com

1.2 *Stormwater Team*

Stormwater Team		
Name and/or position, and contact	Responsibilities	I Have Read the CGP and Understand the Applicable Requirements
Chuck McWilliams Senior Superintendent 508-962-2237 cmcwilliams@consigli.com	Project oversight & implementing, maintaining and inspecting stormwater controls	☒ Yes Date: 3/27/2020

SECTION 2: SITE EVALUATION, ASSESSMENT, AND PLANNING

2.1 Project/Site Information

Project Name and Address

Project/Site Name: Arlington High School Early Bidding Package
Project Street/Location: 869 Massachusetts Ave
City: Arlington
State: Massachusetts
ZIP Code: 02476
County or Similar Subdivision: Middlesex

Business days and hours for the project: M – F, Saturday. 7:00 am to 3:30 PM

Project Latitude/Longitude

Latitude: 42.417100° N (decimal degrees)

Longitude: - 71.162990 ° W (decimal degrees)

Latitude/longitude data source:

☐ Map ☒ GPS ☐ Other (please specify): __________________________________

Horizontal Reference Datum:

☐ NAD 27 ☒ NAD 83 ☐ WGS 84

Additional Project Information

Are you requesting permit coverage as a "federal operator" as defined in Appendix A of the 2017 CGP? ☐ Yes ☒ No

Is the project/site located on Indian country lands, or located on a property of religious or cultural significance to an Indian tribe? ☐ Yes ☒ No

If yes, provide the name of the Indian tribe associated with the area of Indian country (including the name of Indian reservation if applicable), or if not in Indian country, provide the name of the Indian tribe associated with the property:

If you are conducting earth-disturbing activities in response to a public emergency, document the cause of the public emergency *(e.g., natural disaster, extreme flooding conditions)*, information substantiating its occurrence *(e.g., state disaster declaration)*, and a description of the construction necessary to reestablish effective public services:

2.2 Discharge Information

Does your project/site discharge stormwater into a Municipal Separate Storm Sewer System (MS4)?	☒ Yes ☐ No
Are there any waters of the U.S. within 50 feet of your project's earth disturbances?	☐ Yes ☒ No

For each point of discharge, provide a point of discharge ID (a unique 3-digit ID, e.g., 001, 002), the name of the first water of the U.S. that receives stormwater directly from the point of discharge and/or from the MS4 that the point of discharge discharges to, and the following receiving water information, if applicable:								
Point of Discharge ID	Name of receiving water:	Is the receiving water impaired (on the CWA 303(d) list)?	If yes, list the pollutants that are causing the impairment:	Has a TMDL been completed for this receiving waterbody?	If yes, list TMDL Name and ID:	Pollutant(s) for which there is a TMDL:	Is this receiving water designated as a Tier 2, Tier 2.5, or Tier 3 water?	If yes, specify which Tier (2, 2.5, or 3)?
[001]	Boston Harbor: Mystic	☒ Yes ☐ No	Pathogens	☒ Yes ☐ No	Boston Harbor (MA70-01)	Fecal Coliform, Enterococci bacteria	☒ Yes ☐ No	Tier 2

2.3 *Nature of the Construction Activities*

General Description of Project

Early Bid Package- The proposed project will consist of removal/abandonment of existing utilities with re-routing of necessary utilities to keep the existing high school's services up and running throughout the construction project. It will also include relocation of a large culvert currently running beneath the school and temporary parking lots and parking.

Size of Construction Site

Size of Property	21 Acres
Total Area Expected to be Disturbed by Construction Activities	6.0 Acres
Maximum Area Expected to be Disturbed at Any One Time	6.0 Acres

Type of Construction Site *(check all that apply):*

☐ Single-Family Residential ☐ Multi-Family Residential ☐ Commercial ☐ Industrial
☒ Institutional ☐ Highway or Road ☐ Utility ☐ Other ____________________

Will there be demolition of any structure built or renovated before January 1, 1980?	☒ Yes ☐ No
If yes, do any of the structures being demolished have at least 10,000 square feet of floor space?	☒ Yes ☐ No ☐ N/A
Was the pre-development land use used for agriculture (see Appendix A for definition of "agricultural land")?	☐ Yes ☒ No

Pollutant-Generating Activities

List and describe all pollutant-generating activities and indicate for each activity the type of pollutant that will be generated. Take into account where potential spills and leaks could occur that contribute pollutants to stormwater discharges, and any known hazardous or toxic substances, such as PCBs and asbestos, that will be disturbed during construction.

Pollutant-Generating Activity (e.g., paving operations; concrete, paint, and stucco washout and waste disposal; solid waste storage and disposal; and dewatering operations)	**Pollutants or Pollutant Constituents** (e.g., sediment, fertilizers, pesticides, paints, caulks, sealants, fluorescent light ballasts, contaminated substrates, solvents, fuels)
Paving Operation	Petroleum
Concrete/Paving	Cement
Landscaping	Fertilizers, sediment
Grading, Clearing & Grubbing	Sediment
Hydraulic Fluid/Fluids	Mineral Oil
Construction Vehicles	Benzene, ethyl benzene, toluene, xylene, MTBE, petroleum distillate, oil, grease, naphthalene, xylenes, mineral oil

Glue/Solvents	Polymer, epoxies

Construction Support Activities *(only provide if applicable)*
Describe any construction support activities for the project (e.g., concrete or asphalt batch plants, equipment staging yards, material storage areas, excavated material disposal areas, borrow areas):

Grading

Concrete Paving

Equipment/Material Staging areas

Contact information for construction support activity:
TBD

2.4 Sequence and Estimated Dates of Construction Activities

Phase I

Early Bid Package Phase 1	
Estimated Start Date of Construction Activities for this Phase	4/15/2020
Estimated End Date of Construction Activities for this Phase	12/24/2021
Estimated Date(s) of Application of Stabilization Measures for Areas of the Site Required to be Stabilized	3/31/2020 *[Add additional dates as necessary]*
Estimated Date(s) when Stormwater Controls will be Removed	11/26/2021 *[Add additional dates as necessary]*

Phase II

Construction Phase 2, 3 & 4	
Estimated Start Date of Construction Activities for this Phase	1/3/2022
Estimated End Date of Construction Activities for this Phase	6/27/2025
Estimated Date(s) of Application of Stabilization Measures for Areas of the Site Required to be Stabilized	11/26/2021 *[Add additional dates as necessary]*
Estimated Date(s) when Stormwater Controls will be Removed	8/1/2025 *[Add additional dates as necessary]*

2.5 Authorized Non-Stormwater Discharges

List of Authorized Non-Stormwater Discharges Present at the Site

Type of Authorized Non-Stormwater Discharge	Likely to be Present at Your Site?
Discharges from emergency fire-fighting activities	☐ Yes ☒ No
Fire hydrant flushings	☐ Yes ☒ No
Landscape irrigation	☐ Yes ☒ No
Waters used to wash vehicles and equipment	☒ Yes ☐ No
Water used to control dust	☒ Yes ☐ No
Potable water including uncontaminated water line flushings	☐ Yes ☒ No
External building washdown (soaps/solvents are not used and external surfaces do not contain hazardous substances)	☐ Yes ☒ No
Pavement wash waters	☐ Yes ☒ No
Uncontaminated air conditioning or compressor condensate	☐ Yes ☒ No
Uncontaminated, non-turbid discharges of ground water or spring water	☐ Yes ☒ No
Foundation or footing drains	☐ Yes ☒ No
Construction dewatering water	☒ Yes ☐ No

2.6 Site Maps

Will be provided under separate cover.

SECTION 3: DOCUMENTATION OF COMPLIANCE WITH OTHER FEDERAL REQUIREMENTS

3.1 Endangered Species Protection

Eligibility Criterion

Under which criterion listed in Appendix D are you eligible for coverage under this permit?

☒ **Criterion A**: No ESA-listed species and/or designated critical habitat present in action area. Using the process outlined in Appendix D of this permit, you certify that ESA-listed species and designated critical habitat(s) under the jurisdiction of the USFWS or NMFS are not likely to occur in your site's "action area" as defined in Appendix A of this permit.

Basis statement content/Supporting documentation: A basis statement supporting the selection of Criterion A should identify the USFWS and NMFS information sources used. Attaching aerial image(s) of the site to your NOI is helpful to EPA, USFWS, and NMFS in confirming eligibility under this criterion. Please Note: NMFS' jurisdiction includes ESA-listed marine and estuarine species that spawn in inland rivers. Check the applicable source(s) of information you relied upon:

☐ Specific communication with staff of the USFWS and/or NMFS.

☒ Species list from USFWS and/or NMFS. See the CGP ESA webpage, Step 2 for available websites. Oliver GIS See Appendix K

☐ **Criterion B:** Eligibility requirements met by another operator under the 2017 CGP. The construction site's discharges and discharge-related activities were already addressed in another operator's valid certification of eligibility for your "action area" under eligibility Criterion A, C, D, E, or F of the 2017 CGP and you have confirmed that no additional ESA-listed species and/or designated critical habitat under the jurisdiction of USFWS and/or NMFS not considered in the that certification may be present or located in the "action area." To certify your eligibility under this criterion, there must be no lapse of NPDES permit coverage in the other CGP operator's certification. By certifying eligibility under this criterion, you agree to comply with any conditions upon which the other CGP operator's certification was based. You must include in your NOI the NPDES ID from the other 2017CGP operator's notification of authorization under this permit. If your certification is based on another 2017 CGP operator's certification under criterion C, you must provide EPA with the relevant supporting information required of existing dischargers in criterion C in your NOI form.

Basis statement content/Supporting documentation: A basis statement supporting the selection of Criterion B should identify the eligibility criterion of the other CGP NOI, the authorization date, and confirmation that the authorization is effective.

- ✓ Provide the 9-digit NPDES ID number from the other operator's NOI under the 2017 CGP: __ __ __ __ __ __ __ __ __
- ✓ Authorization date of the other 2017 CGP operator: INSERT AUTHORIZATION DATE OF OTHER OPERATOR
- ✓ Eligibility criterion of the other 2017 CGP operator: ☐A ☐C ☐D ☐E ☐F
- ✓ Provide a brief summary of the basis the other operator used for selecting criterion A, C, D, E, or F: Review of NHESP data provided within State GIS system.

☐ **Criterion C:** Discharges not likely to adversely affect ESA-listed species and/or designated critical habitat. ESA-listed species and/or designated critical habitat(s) under the jurisdiction of the USFWS and/or NMFS are likely to occur in or near your site's "action area," and you certify to EPA that your site's discharges and discharge-related activities are not likely to adversely affect ESA-listed threatened or endangered species and/or designated critical habitat. This certification may include consideration of any stormwater controls and/or management practices you will adopt to ensure that your discharges and discharge-related activities are not likely to adversely affect ESA-listed species and/or designated critical habitat. To certify your eligibility under this criterion, indicate 1) the ESA-listed species and/or designated habitat located in your "action area" using the process outlined in Appendix D of this permit; 2) the distance between the site and the listed species and/or designated critical habitat in the action area (in miles); and 3) a rationale describing specifically how adverse effects to ESA-listed species will be avoided from the discharges and discharge-related activities. You must also include a copy of your site map from your SWPPP showing the upland and in-water extent of your "action area" with this NOI.

Basis statement content/Supporting documentation: A basis statement supporting the selection of Criterion C should identify the information resources and expertise (e.g., state or federal biologists) used to arrive at this conclusion. Any supporting documentation should explicitly state that both ESA-listed species and designated critical habitat under the jurisdiction of the USFWS and/or NMFS were considered in the evaluation.

- ✓ Resources used to make determination: INSERT RESOURCES YOU USED TO DETERMINE THAT DISCHARGES ARE NOT LIKELY TO ADVERSELY AFFECT ESA-LISTED SPECIES OR DESIGNATED CRITICAL HABITAT
- ✓ ESA-listed Species/Critical Habitat in action area: INSERT LIST OF ESA-LISTED SPECIES OR DESIGNATED CRITICAL HABITAT LOCATED IN YOUR ACTION AREA
- ✓ Distance between site and ESA-listed Species/Critical Habitat: INSERT DISTANCE BETWEEN YOUR SITE AND THE ESA-LISTED SPECIES OR CRITICAL HABITAT (in miles)
- ✓ How adverse effects will be avoided: DESCRIBE SPECIFICALLY HOW ADVERSE EFFECTS TO ESA-LISTED SPECIES WILL BE AVOIDED FROM THE DISCHARGES AND DISCHARGE-RELATED ACTIVITIES

☐ **Criterion D**: Coordination with USFWS and/or NMFS has successfully concluded. Coordination between you and the USFWS and/or NMFS has concluded. The coordination must have addressed the effects of your site's discharges and discharge-related activities on ESA-listed species and/or designated critical habitat under the jurisdiction of USFWS and/or NMFS, and resulted in a written concurrence from USFWS and/or NMFS that your site's discharges and discharge-related activities are not likely to adversely affect listed species and/or critical habitat. You must include copies of the correspondence with the participating agencies in your SWPPP and this NOI.

Basis statement content/Supporting documentation: A basis statement supporting the selection of Criterion D should identify whether USFWS or NMFS or both agencies participated in coordination, the field office/regional office(s) providing that coordination, and the date that coordination concluded.

- ✓ Agency coordinated with: ☐USFWS ☐ NMFS
- ✓ Field/regional office(s) providing coordination: INSERT FIELD/REGIONAL OFFICE(S) PROVIDING COORDINATION
- ✓ Date coordination concluded: INSERT DATE COORDINATION CONCLUDED

- ✓ Attach copies of any letters or other communication between you and the U.S. Fish & Wildlife Service or National Marine Fisheries Service concluding coordination activities.

☐ **Criterion E:** ESA Section 7 consultation has successfully concluded. Consultation between a Federal Agency and the USFWS and/or NMFS under section 7 of the ESA has concluded. The consultation must have addressed the effects of the construction site's discharges and discharge-related activities on ESA-listed species and/or designated critical habitat under the jurisdiction of USFWS and/or NMFS. To certify eligibility under this criterion, Indicate the result of the consultation:

- ☐ Biological opinion from USFWS and/or NMFS that concludes that the action in question (taking into account the effects of your site's discharges and discharge-related activities) is not likely to jeopardize the continued existence of listed species, nor the destruction or adverse modification of critical habitat; or
- ☐ Written concurrence from USFWS and/or NMFS with a finding that the site's discharges and discharge-related activities are not likely to adversely affect ESA-listed species and/or designated critical habitat. You must include copies of the correspondence between yourself and the USFWS and/or NMFS in your SWPPP and this NOI.

Basis statement content/Supporting documentation: A basis statement supporting the selection of Criterion E should identify the federal action agency(ies) involved, the field office/regional office(s) providing that consultation, any tracking numbers of identifiers associated with that consultation (e.g., IPaC number, PCTS number), and the date the consultation was completed.

- ✓ Federal agency(ies) involved: INSERT FEDERAL AGENCY(IES) INVOLVED
- ✓ Field/regional office(s) providing consultation: INSERT FIELD/REGIONAL OFFICE(S) PROVIDING CONSULTATION
- ✓ Tracking numbers associated with consultation: INSERT CONSULTATION TRACKING NUMBER(S)
- ✓ Date consultation completed: INSERT DATE CONSULTATION COMPLETED
- ✓ Attach copies of any letters or other communication between you and the U.S. Fish & Wildlife Service or National Marine Fisheries Service concluding consultation.

☐ **Criterion F:** Issuance of section 10 permit. Potential take is authorized through the issuance of a permit under section 10 of the ESA by the USFWS and/or NMFS, and this authorization addresses the effects of the site's discharges and discharge-related activities on ESA-listed species and designated critical habitat. You must include copies of the correspondence between yourself and the participating agencies in your SWPPP and your NOI.

Basis statement content/Supporting documentation: A basis statement supporting the selection of Criterion F should identify whether USFWS or NMFS or both agencies provided a section 10 permit, the field office/regional office(s) providing permit(s), any tracking numbers of identifiers associated with that consultation (e.g., IPaC number, PCTS number), and the date the permit was granted.

- ✓ Agency providing section 10 permit: ☐USFWS ☐NMFS
- ✓ Field/regional office(s) providing permit: INSERT FIELD/REGIONAL OFFICE(S) PROVIDING PERMIT

- ✓ Tracking numbers associated with consultation: INSERT CONSULTATION TRACKING NUMBER(S)
- ✓ Date permit granted: INSERT DATE PERMIT GRANTED
- ✓ Attach copies of any letters or other communication between you and the U.S. Fish & Wildlife Service or National Marine Fisheries Service.

3.2 Historic Preservation

Appendix E, Step 1

Do you plan on installing any of the following stormwater controls at your site? Check all that apply below, and proceed to Appendix E, Step 2.

☐ Dike

☐ Berm

☒ Catch Basin

☐ Pond

☒ Stormwater Conveyance Channel (e.g., ditch, trench, perimeter drain, swale, etc.)

☒ Culvert

☐ Other type of ground-disturbing stormwater control: INSERT SPECIFIC TYPE OF STORMWATER CONTROL

(Note: If you will not be installing any ground-disturbing stormwater controls, no further documentation is required for Section 3.2 of the Template.)

Appendix E, Step 2

If you answered yes in Step 1, have prior surveys or evaluations conducted on the site already determined that historic properties do not exist, or that prior disturbances at the site have precluded the existence of historic properties? ☒ YES ☐ NO

- If yes, no further documentation is required for Section 3.2 of the Template.
- If no, proceed to Appendix E, Step 3.

Appendix E, Step 3

If you answered no in Step 2, have you determined that your installation of subsurface earth-disturbing stormwater controls will have no effect on historic properties? ☐ YES ☐ NO

If yes, provide documentation of the basis for your determination.

If no, proceed to Appendix E, Step 4.

Appendix E, Step 4

If you answered no in Step 3, did the State Historic Preservation Officer (SHPO), Tribal Historic Preservation Office (THPO), or other tribal representative (whichever applies) respond to you within 15 calendar days to indicate whether the subsurface earth disturbances caused by the installation of stormwater controls affect historic properties? ☐ YES ☐ NO

If no, no further documentation is required for Section 3.2 of the Template.

If yes, describe the nature of their response:

☐ Written indication that no historic properties will be affected by the installation of stormwater controls. INSERT COPIES OF LETTERS, EMAILS, OR OTHER COMMUNICATION BETWEEN YOU AND THE APPLICABLE SHPO, THPO, OR OTHER TRIBAL REPRESENTATIVE

☐ Written indication that adverse effects to historic properties from the installation of stormwater controls can be mitigated by agreed upon actions. INSERT COPIES OF LETTERS, EMAILS, OR OTHER COMMUNICATION BETWEEN YOU AND THE APPLICABLE SHPO, THPO, OR OTHER TRIBAL REPRESENTATIVE

☐ No agreement has been reached regarding measures to mitigate effects to historic properties from the installation of stormwater controls. INSERT COPIES OF LETTERS, EMAILS, OR OTHER COMMUNICATION BETWEEN YOU AND THE APPLICABLE SHPO, THPO, OR OTHER TRIBAL REPRESENTATIVE

☐ Other: INSERT COPIES OF LETTERS, EMAILS, OR OTHER COMMUNICATION BETWEEN YOU AND THE APPLICABLE SHPO, THPO, OR OTHER TRIBAL REPRESENTATIVE

3.3 Safe Drinking Water Act Underground Injection Control Requirements

Do you plan to install any of the following controls? Check all that apply below.

☐ Infiltration trenches (if stormwater is directed to any bored, drilled, driven shaft or dug hole that is deeper than its widest surface dimension, or has a subsurface fluid distribution system)

☒ Commercially manufactured pre-cast or pre-built proprietary subsurface detention vaults, chambers, or other devices designed to capture and infiltrate stormwater flow

☐ Drywells, seepage pits, or improved sinkholes (if stormwater is directed to any bored, drilled, driven shaft or dug hole that is deeper than its widest surface dimension, or has a subsurface fluid distribution system)

IF YES, INSERT COPIES OF LETTERS, EMAILS, OR OTHER COMMUNICATION BETWEEN YOU AND THE STATE AGENCY OR EPA REGIONAL OFFICE

SECTION 4: EROSION AND SEDIMENT CONTROLS

4.1 Natural Buffers or Equivalent Sediment Controls

Buffer Compliance Alternatives

Are there any waters of the U.S. within 50 feet of your project's earth disturbances? ☒ YES ☐ NO

(Note: If no, no further documentation is required for Part 4.1 in the SWPPP Template. Continue on to Part 4.2.)

Check the compliance alternative that you have chosen:

☐ (i) I will provide and maintain a 50-foot undisturbed natural buffer.

(Note (1): You must show the 50-foot boundary line of the natural buffer on your site map.)

(Note (2): You must show on your site map how all discharges from your construction disturbances through the natural buffer area will first be treated by the site's erosion and sediment controls. Also, show on the site map any velocity dissipation devices used to prevent erosion within the natural buffer area.)

☐ (ii) I will provide and maintain an undisturbed natural buffer that is less than 50 feet and is supplemented by additional erosion and sediment controls, which in combination achieves the sediment load reduction equivalent to a 50-foot undisturbed natural buffer.

(Note (1): You must show the boundary line of the natural buffer on your site map.)

(Note (2): You must show on your site map how all discharges from your construction disturbances through the natural buffer area will first be treated by the site's erosion and sediment controls. Also, show on the site map any velocity dissipation devices used to prevent erosion within the natural buffer area.)

- INSERT WIDTH OF NATURAL BUFFER TO BE RETAINED
- INSERT EITHER ONE OF THE FOLLOWING:

  (1) THE ESTIMATED SEDIMENT REMOVAL FROM A 50-FOOT BUFFER USING APPLICABLE TABLES IN APP. G, ATTACHMENT 1. INCLUDE INFORMATION ABOUT THE BUFFER VEGETATION AND SOIL TYPE THAT PREDOMINATE AT YOUR SITE

  OR

  (2) IF YOU CONDUCTED A SITE-SPECIFIC CALCULATION FOR THE ESTIMATED SEDIMENT REMOVAL OF A 50-FOOT BUFFER, PROVIDE THE SPECIFIC REMOVAL EFFICIENCY, AND INFORMATION YOU RELIED UPON TO MAKE YOUR SITE-SPECIFIC CALCULATION.
- INSERT DESCRIPTION OF ADDITIONAL EROSION AND SEDIMENT CONTROLS TO BE USED IN COMBINATION WITH NATURAL BUFFER AREA
- INSERT THE FOLLOWING INFORMATION:
  - (1) SPECIFY THE MODEL OR OTHER TOOL USED TO ESTIMATE SEDIMENT LOAD REDUCTIONS FROM THE COMBINATION OF THE BUFFER AREA AND ADDITIONAL EROSION AND SEDIMENT CONTROLS INSTALLED AT YOUR SITE, AND
  - (2) INCLUDE THE RESULTS OF CALCULATIONS SHOWING THAT THE COMBINATION OF YOUR BUFFER AREA AND THE ADDITIONAL EROSION AND SEDIMENT CONTROLS INSTALLED AT YOUR SITE WILL MEET OR EXCEED THE SEDIMENT REMOVAL EFFICIENCY OF A 50-FOOT BUFFER

☒ (iii) It is infeasible to provide and maintain an undisturbed natural buffer of any size, therefore I will implement erosion and sediment controls that achieve the sediment load reduction equivalent to a 50-foot undisturbed natural buffer.

Contractor will provide appropriate erosion control methods to simulate a 50 ft vegetated buffer.

☐ I qualify for one of the exceptions in Part 2.2.1.b. (If you have checked this box, provide information on the applicable buffer exception that applies, below.)

Buffer Exceptions
Which of the following exceptions to the buffer requirements applies to your site?

☐ There is no discharge of stormwater to the water of the U.S. that is located 50 feet from my construction disturbances.

(Note: If this exception applies, no further documentation is required for Section 4.1 of the Template.)

☒ No natural buffer exists due to preexisting development disturbances that occurred prior to the initiation of planning for this project.

(Note (1): If this exception applies, no further documentation is required for Section 4.1 of the Template.)

(Note (2): Where some natural buffer exists but portions of the area within 50 feet of the surface water are occupied by preexisting development disturbances, you must still comply with the one of the CGP Part 2.2.1.a compliance alternatives.)

☐ For a "linear construction sites" (defined in Appendix A), site constraints (e.g., limited right-of-way) make it infeasible to meet any of the CGP Part 2.2.1.a compliance alternatives. INCLUDE DOCUMENTATION HERE OF THE FOLLOWING: (1) WHY IT IS INFEASIBLE FOR YOU TO MEET ONE OF THE BUFFER COMPLIANCE ALTERNATIVES, AND (2) BUFFER WIDTH RETAINED AND/OR SUPPLEMENTAL EROSION AND SEDIMENT CONTROLS TO TREAT DISCHARGES TO THE SURFACE WATER

☐ The project qualifies as "small residential lot" construction (defined in Appendix A) (see Appendix G, Part G.3.2).

☐ For Alternative 1:

- INSERT WIDTH OF NATURAL BUFFER TO BE RETAINED
- INSERT APPLICABLE REQUIREMENTS BASED ON TABLE G-1
- INSERT DESCRIPTION OF HOW YOU WILL COMPLY WITH THESE REQUIREMENTS

☐ For Alternative 2:

- INSERT (1) THE ASSIGNED RISK LEVEL BASED ON APP. G APPLICABLE TABLE G-2 THROUGH G-6 AND (2) THE PREDOMINANT SOIL TYPE AND AVERAGE SLOPE AT YOUR SITE
- INSERT APPLICABLE REQUIREMENTS BASED ON APP. G, TABLE G-7
- INSERT DESCRIPTION OF HOW YOU WILL COMPLY WITH THESE REQUIREMENTS

☐ Buffer disturbances are authorized under a CWA Section 404 permit. INSERT DESCRIPTION OF ANY EARTH DISTURBANCES THAT WILL OCCUR WITHIN THE BUFFER AREA

(Note (1): If this exception applies, no further documentation is required for Section 4.1 of the Template.)
(Note (2): This exception only applies to the limits of disturbance authorized under the Section 404 permit, and does not apply to any upland portion of the construction project.)

☐ Buffer disturbances will occur for the construction of a water-dependent structure or water access area (e.g., pier, boat ramp, and trail). INSERT DESCRIPTION OF ANY EARTH DISTURBANCES THAT WILL OCCUR WITHIN THE BUFFER AREA
(Note (1): If this exception applies, no further documentation is required for Section 4.1 of the Template.)

4.2 Perimeter Controls

General

- Straw Wattles and Silt Fences shall be installed as shown on the Soil Erosion plans provided by Samiotes Consultants, Inc. prior to the commencement of construction. Additional erosion control barriers will be placed at the limit of work as needed and in any sensitive areas as work progresses.

Specific Perimeter Controls

Straw Wattles	
Description: Straw Wattles shall be manufactured from rice straw and be wrapped in a tubular plastic netting. Straw Wattles shall be a minimum of 9 to 12 inches in diameter.	
Installation	• Prior to the start of construction. • Straw Wattles shall be installed as shown on the plans. They shall be placed in rows with ends overlapping each other by 36" minimum. Each row shall be securely anchored in place in a 4" deep trench with stakes installed downstream of the wattles at sufficient spacing to prevent wattles from moving.
Maintenance Requirements	• Sedimentation shall be removed once the total depth of silt reaches 6". • Silt shall be disposed of in accordance with SWPPP.
Design Specifications	See sheet C-5.0 and specification 31 25 00 Erosion and Sediment Control.

Silt Fences	
Description: A geotextile fabric shall consist of long-chain synthetic polymers, composed of at least 85% by weight polyolefin, polyesters, or polyamides. The support fences shall be at least 48 inches high and strong enough to support applied loads.	
Installation	• Prior to the start of construction. • Straw Wattles shall be installed as shown on the plans. Wood posts shall consist of 1 ½" square, kiln dried, and hardwood posts. Steel posts of U, T, L, or C shape weighing 1.3 pounds per linear foot. Filter fabric shall be attached to wood posts with staples with 13 gage minimum, galvanized steel wire for steel post application.
Maintenance Requirements	• Sedimentation shall be removed once the total depth of silt reaches 6". Silt shall be removed off site abiding by local jurisdiction.
Design Specifications	See specification 31 25 00 Erosion and Sediment Control.

4.3 Sediment Track-Out

General

- The construction entrances shall be placed at the West and South sides of the building site off of Massachusetts Ave and Schouler Court and off of Mill Brook Drive. In addition to the construction entrance, an geotextile fabric shall be nonwoven fabric conforming to AASHTO M288, Grade C or better will be installed to ensure no debris leaves the site. A mechanical street sweeper shall be utilized clean the existing paved areas on an as-needed basis.

Specific Track-Out Controls

GeoTextile Fabric	
Description: The construction entrance shall be a minimum of 50-feet in length and 10-feet wide, and the thickness shall not be less than 6" of crushed stone. In addition to the construction entrance, a mechanical street sweeper shall be utilized to clean the existing paved areas on an as-needed basis.	
Installation	Prior to the start of construction
Maintenance Requirements	• The entrance shall be maintained in a condition which will prevent tracking or flowing of sediment onto public rights-of-way. All sediment spoiled, dropped, washed, or tracked onto public rights of way must be removed immediately. • The area of the construction entrance shall be cleared of all vegetation, roots, and other objectionable material. The filter fabric should be placed on the subgrade prior to the gravel placement. The gravel shall be placed to the specified dimensions depicted on the plans. The filter fabric should be placed on the subgrade prior to the gravel placement. The gravel shall be placed to the specified dimensions depicted on the plans.
Design Specifications	Stone shall be clean, crushed stone, ranging from [1 in. to 3 in.] in size. Stone shall not be less than 6 in. thick. The rock shall be dumped and spread into position in approximately horizontal layers not to exceed 3 ft. in thickness. It shall be placed to produce a reasonably homogeneous stable fill that contains no segregated pockets of large or small fragments or large unfilled spaces caused by bridging of the larger rock fragments. No compaction is required beyond that resulting from the placing and spreading operations.

4.4 Stockpiled Sediment or Soil

General

1. Cut and fill slopes and stockpiled materials shall be protected to prevent erosion with permanent erosion protection when erosion exposure period is expected to be greater than or equal to six months, and temporary erosion protection when erosion exposure

period is expected to be less than six months. Cut and fill slopes shall be limited to a grade of 2:1 (horizontal:vertical).

Specific Stockpile Controls

Stockpile	
Description: Stripping and stockpiling	
Installation	• As needed. • Locate and retain soil materials away from edge of excavations, brush, trash, large stones and other extraneous materials.
Maintenance Requirements	• Do not strip topsoil in tree protection zones. • Remove sod and grass before stripping topsoil. • Surplus topsoil and fill not required to fulfill the requirements of the contract shall become the property of the contractor and shall be removed from the site and legally disposed of at no cost to the owner.
Design Specifications	See specification 31 25 00 Erosion and Sediment Control.

- All temporary stockpiles will be surrounded by straw wattles and/or silt fences to minimize erosion and limit the discharge of pollutants. It is expected that minimal stockpiling will occur on site, if straw wattles provide proper erosion control they may be used without silt fences.

Silt Fence with Straw Wattles	
Description: Silt Fence with Straw Wattles	
Installation	• As needed
Maintenance Requirements	• Silt fence shall be inspected for depth of sediment, tears, to see if the fabric is securely attached to the fence posts, and to see that the fence posts are firmly set in the ground.
Design Specifications	See Specification 312500 Erosion and Sediment Control, detail 1 on sheet C-5.0.

4.5 Minimize Dust

General

- The contractor shall employ dust control methods and materials at all times using sprinkled water or other approved means. Do not use oil or similar penetrants. Chemical materials may not be used on subgrades of areas to be seeded or planted. Water used for dust control measure shall be applied using appropriate quantities and equipment.

Specific Dust Controls

Sprinkler	
Description: On-site truck or sprinkler	
Installation	As needed

Maintenance Requirements	• Water used for dust control and equipment washes shall be clean and free of salt, oil, and other injurious materials. • If water is not available on site, the contractor shall provide a source of water for dust control; either a water truck on-site or permitted connection to City Fire Hydrant throughout the period of construction. • No calcium chloride may be used
Design Specifications	N/A

4.6 Minimize Steep Slope Disturbances

General

- Steep slopes are not anticipated to occur on this project. Except where specified slope is indicated on drawings, fill slopes shall be limited to a grade of 2:1 (horizontal: vertical), cut slopes shall be limited to a grade of 2:1.

Specific Steep Slope Controls

Erosion Protection Materials	
Description: N/A	
Installation	N/A
Maintenance Requirements	N/A
Design Specifications	N/A

Seeding with grass	
Description: N/A	
Installation	N/A
Maintenance Requirements	N/A
Design Specifications	N/A

4.7 Topsoil

General

- All temporary stockpiles shall be protected from rain and wind erosion with compost filler tubes and straw waddles.

Specific Topsoil Controls

Silt fences with straw wattles	
Description: Silt fences with straw wattles	
Installation	As needed.
Maintenance Requirements	Weekly inspection and after any significant rainstorm.
Design Specifications	See specification 31 25 00 and sheet C-5.0.

Straw wattles	
Description: Straw wattles	
Installation	As needed.
Maintenance Requirements	Weekly inspection and after any significant rainstorm.
Design Specifications	See specification 31 25 00.

4.8 Soil Compaction

General

- Areas with fill, backfill, and subgrades will be required for compaction. This includes any earthwork, paving, drainage trenches and retaining walls. See respective specifications for all description and maintenance requirements.

Specific Soil Compaction Controls

Soil Compaction	
Description: Soil compaction on site.	
Installation	As needed
Maintenance Requirements	• Subgrade of areas to be paved shall be re-compacted as required to bring top 9 in. of material immediately below gravel base course to a compaction of at least 90% of maximum dry density, as determined by ASTM D 1557, Method D Subgrade compaction shall extend for a distance of at least 1 ft. beyond pavement edge. • Gravel shall be spread and compacted in layers not exceeding 8 inches in depth, except the last layer of gravel sub-base (conforming to Mass DOT specifications section M1.03.0 Type B) will be 4" in depth. Layers shall be compacted to 95 percent of the maximum dry density of the material as determined by standard AASHTO test designation T99 compaction test method C at optimum moisture content as determined by the architect. • Dense graded crushed stone shall be spread and compacted in layers not exceeding 8 inches in depth, except the last layer of gravel sub-base (conforming to Mass DOT specification M1.03.0 Type B) will be 4" in depth. Layers shall be compacted to 95 percent of the maximum dry density of the material as determined by Standard AASHTO test designation T99 compaction test Method C at optimum moisture content as determined by the architect. • If the geotechnical engineer determines that the fill material is too dry for proper compaction, water shall be added to provide the specified optimum moisture content, as necessary for proper compaction.
Design Specifications	See specification 32 12 16 Asphalt Paving, 33 10 00 Water Systems, 33 30 00 Sanitary Sewage System, and 33 30 00 Storm Drainage System.

4.9 Storm Drain Inlets

General

- Catch Basins Rain Gardens and Slab Drains shall be used to filter suspended sediments from entering stormwater flow.

Specific Storm Drain Inlet Controls

Catch Basin Insert	
Description: • Catch Basin insert shall be installed in retained existing and proposed catch basins and area drains as shown on Construction Documents and as required by the Engineer of Record. • Catch basin filters shall be manufactured from a woven polypropylene geotextile and sewn by a double needle machine, using a high strength nylon thread. Seams have a certified average wide width strength per ASTM D-4884 of 165.0 lbs./in. • The filters will be manufactured to fit the opening of the catch basin or drop inlet. The filters will have the following features: two dump straps attached at the bottom to facilitate the emptying of the filters; the filters will also have lifting loops as an integral part of the system to be used to lift the filters from the basin. The filters will have a restraint cord approximately halfway up the sack to keep the sides away from the catch basin walls; this yellow cord shall also be a visual means of indicating when the sack should be emptied.	
Installation	• Catch basin, filters shall be placed at all inlets to drainage structures as structures are installed and prior to construction. Outlet protection work shall be constructed before runoff is allowed to enter the drainage system. Construction and location of catch basin filters shall be as indicated on the Drawings. • Once the strap is covered with sediment, the catch basin filter should be emptied, cleaned and placed back into the basin with a depth of 6 inches.
Maintenance Requirements	• The Contractor shall inspect the condition of catch basin insert after each rainstorm and during major rain events. • Catch basin insert shall be cleaned periodically to remove and disposed of accumulated debris as required. Silt sacks, which become damaged during construction operations, shall be repaired or replaced immediately at no additional cost to the Department. • When emptying the catch basin insert, the contractor shall take all due care to prevent sediment from entering the structure. Any silt or other debris found in the drainage system at the end of construction shall be removed at the Contractors expense. • The silt and sediment from the catch basin insert shall be legally disposed of offsite. Under no condition shall silt and sediment from the insert be deposited on site and used in construction. • All curb openings shall be blocked to prevent stormwater from bypassing the device.
Design Specifications	See Specification 312500 Erosion and Sediment Control and detail 6 on C-5.1.

4.10 Stormwater Conveyance Channels

General

- No conveyance channels are anticipated as part of the project.

Specific Conveyance Channel Controls

N/A	
Description: N/A	
Installation	• N/A
Maintenance Requirements	• N/A
Design Specifications	N/A

4.11 Sediment Basins

General

- No sediment basins are anticipated as part of this project.

4.12 Chemical Treatment

Soil Types
List all the soil types (including soil types expected to be found in fill material) that are expected to be exposed during construction in areas of the project that will drain to chemical treatment systems: Reference McPhail NOI RGP dated 02/24/20

Treatment Chemicals
List all treatment chemicals that will be used at the site and explain why these chemicals are suited to the soil characteristics: Reference McPhail NOI RGP dated 02/24/20
Describe the dosage of all treatment chemicals you will use at the site or the methodology you will use to determine dosage: Reference McPhail NOI RGP dated 02/24/20

Provide information from any applicable Safety Data Sheets (SDS): TBD

Describe how each of the chemicals will stored: In a locked secure on site storage container. Access controlled by treatment subcontractor.

Include references to applicable state or local requirements affecting the use of treatment chemicals, and copies of applicable manufacturer's specifications regarding the use of your specific treatment chemicals and/or chemical treatment systems: INSERT TEXT HERE

Special Controls for Cationic Treatment Chemicals (if applicable)
If the applicable EPA Regional Office authorized you to use cationic treatment chemicals, include the official EPA authorization letter or other communication, and identify the specific controls and implementation procedures designed to ensure that your use of cationic treatment chemicals will not lead to an exceedance of water quality standards: INSERT (1) ANY LETTERS OR OTHER DOCUMENTS SENT FROM THE EPA REGIONAL OFFICE CONCERNING YOUR USE OF CATIONIC TREATMENT CHEMICALS, AND (2) DESCRIPTION OF ANY SPECIFIC CONTROLS YOU ARE REQUIRED TO IMPLEMENT

Schematic Drawings of Stormwater Controls/Chemical Treatment Systems
Provide schematic drawings of any chemically-enhanced stormwater controls or chemical treatment systems to be used for application of treatment chemicals: Reference McPhail NOI RGP dated 02/03/20 Figure 3 pg. 11.

Training
Describe the training that personnel who handle and apply chemicals have received prior to permit coverage, or will receive prior to the use of treatment chemicals: TBD

4.13 Dewatering Practices

General
- Dewatering: Prevent water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area. Under no circumstances shall pipe be installed in water. Keep all trenches free from water until they have been backfilled.

Specific Dewatering Practices

<table>
<tr><th colspan="2">Dewatering</th></tr>
<tr><td colspan="2">Description:
Dewatering shall be used to prevent damages, reduce erosion and control runoff.
The discharge water generated by the construction dewatering will be directed to a temporary detention basin or settling basin as permitted by state regulation.
The pumping discharge shall not be allowed to enter directly into the wetlands. The water from the work areas shall be pumped to a temporary sedimentation and de-watering basin. Approximately 70 percent sedimentation trapping efficiency shall be achieved in sizing the basins to ensure that the basins are adequate to prevent overtopping from dewatering and to provide the required filtering. The outlet from the basin shall be located so as not to cause erosion of the surrounding area.
Locations of the temporary sedimentation and de-watering basins are to be selected by the Contractor within Limit of Work Layout subject to approval from the Design Engineer/ Landscape Architect.</td></tr>
<tr><td>Installation</td><td>At the conclusion of construction dewatering activities, any and all well point and casings, and equipment will be removed from the site.</td></tr>
<tr><td>Maintenance Requirements</td><td>Inspect basin at least twice daily during dewatering operations
Repair any damages to the basin immediately.
Clean basin outlet daily.
Remove any debris immediately.
Remove sediments frequently to maintain efficiency and function of the basin.
Legally dispose sediments outside of wetland areas at a location approved by the Engineer.
Monitor dewatering systems continuously. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations. Comply with governing EPA notification regulations before beginning dewatering. Comply with hauling and disposal regulations of authorities having jurisdiction.</td></tr>
<tr><td>Design Specifications</td><td>N/A</td></tr>
</table>

4.14 Other Stormwater Controls: N/A

General

N/A

Specific Stormwater Control Practices

N/A	
Description: N/A	
Installation	N/A
Maintenance Requirements	N/A
Design Specifications	N/A

4.15 Site Stabilization

Total Amount of Land Disturbance Occurring at Any One Time

☐ *Five Acres or less*

☒ *More than Five Acres*

Use this template box if you are not located in an arid, semi-arid, or drought-stricken area

Temporary Seeding	
☒ *Vegetative* ☐ *Non-Vegetative* ☒ *Temporary* ☐ *Permanent*	
Description: ▪ During construction it may be necessary to temporarily stabilize areas that will not be brought to final grade for a period longer than 30 working days. Temporary seeding is accomplished using fast-growing grass seed species such as ryegrass. ▪ All exposed soil finish grades shall be immediately landscaped, riprapped, loamed, seeded, mulched or otherwise protected and stabilized as shown on the drawings with a layer of straw mulch hay.	
Installation	Exposed grades for longer than 30 days
Completion	As needed
Maintenance Requirements	• Inspect within 6 weeks to see if stands are adequate. • Check for damage after heavy rains. • Stands should be uniform and dense. • Fertilize, reseed, and mulch damaged and sparse areas immediately. Track or tie down much as necessary. • Seeds should be supplied with adequate moisture. • Furnish water as needed.

Design Specifications	See Specification 31 25 00 Erosion and Sediment Control

Straw Hay	
☐ *Vegetative* ☐ *Non-Vegetative* ☒ *Temporary* ☐ *Permanent*	
Description: ▪ All exposed soil finish grades shall be immediately landscaped, riprapped, loamed, seeded, mulched or otherwise protected and stabilized as shown on the drawings with a layer of straw mulch hay. ▪ Outside of the growing season, exposed soil finish grade surfaces shall be stabilized with a layer of straw hay until climate conditions allow for seeding.	
Installation	Exposed grades for longer than 30 days outside of the growing season.
Completion	As Needed
Maintenance Requirements	• Inspect within 6 weeks. • Check for damage after heavy rains.
Design Specifications	See Specification 312500 Erosion and Sediment Control

SECTION 5: POLLUTION PREVENTION STANDARDS

5.1 Potential Sources of Pollution

Construction Site Pollutants

Pollutant-Generating Activity	**Pollutants or Pollutant Constituents** (that could be discharged if exposed to stormwater)	**Location on Site** (or reference SWPPP site map where this is shown)
Construction Vehicles	Benzene, ethyl benzene, toluene, xylene, MTBE, petroleum distillate, oil, grease, naphthalene, xylenes, mineral oil	Within limit of work
Hydraulic Fluid/Fluids	Mineral oil	Potential leaks from broken hoses
Glue/Solvents	Polymer, epoxies	PVC pipe for ductwork
Concrete	Cement	See site plans
Landscaping	Sediment, Fertilizers	See site plans
Grading	Sediment	See site plans
Clearing and Grubbing	Sediment	Topsoil to be removed from within limit of work

Paving	Petroleum	Parking, access ways

5.2 Spill Prevention and Response

- **Material Management Practices:**
  The following are the material management practices that shall be used to reduce the risk of spills or other accidental exposure of materials and substances to stormwater runoff.
- **Good Housekeeping:**
  The following good housekeeping practices will be followed on site during the construction project.
  1. A concerted effort shall be made to store only enough product required to complete a particular task.
  2. All materials stored on site shall be stored in a neat and orderly fashion in their appropriate containers and, if possible, under a roof or other secure enclosure.
  3. Products shall be kept in their original containers with the original manufacturer's label.
  4. Substances shall not be mixed with one another unless recommended by the manufacturer.
  5. Whenever possible, all of a product shall be used up before disposing of the container.
  6. Manufacturer's recommendations for proper use and disposal shall be followed.
  7. The site superintendent shall perform a daily site inspection to ensure proper use and disposal of materials on site.
- **Hazardous Products:**
  The following practices are intended to reduce the risks associated with hazardous materials.
  1. Products shall be kept in original containers unless they are not resealable.
  2. Where feasible, the original labels and material safety data shall be retained, whereas they contain important product information.
  3. If surplus product must be disposed, follow manufacturer's or local and state recommended methods for proper disposal.
- **Product Specific Practices:**
  The following product specific practices shall be followed on site:

  Petroleum Products:
  All on site vehicles shall be monitored for leaks and receive regular preventative maintenance to reduce the risk of leakage. Petroleum products shall be stored in tightly sealed containers which are clearly labeled. Any bituminous concrete or asphalt substances used on site shall be applied according to the manufacturer's recommendations.

  Fertilizers:
  Fertilizers shall be applied in the minimum amounts recommended by the manufacturer. Once applied, fertilizers shall be worked into the soil to limit exposure to stormwater. Storage shall be in a covered shed or trailer. The contents of any partially used bags of fertilizers shall be transferred to a sealable plastic bag or bin to avoid spills. Fertilizers shall be applied in the minimum amounts recommended by the manufacturer. Once applied, fertilizers shall be worked into the soil to limit exposure to stormwater. Storage shall be in a covered shed or trailer. The contents of any partially used bags of fertilizers shall be transferred to a sealable plastic bag or bin to avoid spills.

  Paints:
  All containers shall be tightly sealed and stored when not required for use. Excess paint shall not be discharged into any catch basin, drain manhole, or any portion of the stormwater management system. Excess paint shall be properly disposed of according to manufacturer's recommendations or State and local regulations.

  Concrete Trucks:
  Concrete trucks shall not be allowed to wash out or discharge surplus concrete or drum wash water on site.
- **Spill Control Practices:**
  In addition to the good housekeeping and material management practices discussed in the previous sections of this plan, the following practices shall be followed for spill prevention and cleanup:

1. Manufacturer's recommended methods for cleanup shall be readily available at the on site trailer and site personnel shall be made aware of the procedures and the location of the information.
2. Materials and equipment necessary for spill cleanup shall be kept in the material storage area on site. Equipment and materials shall include, but not be limited to brooms, dust pans, mops, rags, gloves, goggles, kitty litter, sand, sawdust, and plastic and metal trash containers specifically for this purpose.
3. All spills shall be cleaned up immediately after discovery.
4. The spill area shall be kept well ventilated and personnel shall wear appropriate protective clothing to prevent injury from contact with a hazardous substance.
5. Spills of toxic or hazardous material shall be reported to the appropriate State and/or local authority in accordance with local and/or State regulations.

6. The spill prevention plan shall be adjusted to include measures to prevent a particular type of spill from reoccurring and how to clean up the spill if there is another occurrence. A description of the spill, what caused it, and the clean up measures shall also be included.
7. The Town of Needham or their assigned designee shall be the spill prevention and cleanup coordinator. The c Saugus shall designate at least three other site personnel who will be trained in the spill control practices identified above.

If a substantial release occurs that is equal to or exceeds a reportable quantity (RQ) as defined under either 40 CFR Part 110, 40 CFR Part 117, or 40 CFR Part 302, site personnel must notify the National Response Center (NRC) at 1-800-424-8802 as soon as knowledge of the discharge is obtained. Additionally, releases exceeding an RQ as identified in the Massachusetts Contingency Plan

(310 CMR 40.0000) must be reported to the MA DEP. The local fire department should also be informed.

5.3 Fueling and Maintenance of Equipment or Vehicles

General

- Several types of vehicles and equipment will be used on-site throughout the project, including but not limited to graders, scrapers, excavators, loaders, trucks and trailers, backhoes, and forklifts. All major equipment/vehicle maintenance will be performed off-site. When equipment fueling must occur on-site, the fueling activity will occur in the staging area.

Specific Pollution Prevention Practices

Fueling and Maintenance of Equipment or Vehicles	
Description: If necessary, only minor equipment maintenance will occur on-site. All equipment fluids generated from maintenance activities will be disposed of into designated drums stored on spill pallets. Absorbent, spill-cleanup materials and spill kits will be available at the combined staging and materials storage area.	
Installation	As needed
Maintenance Requirements	Equipment shall be inspected daily
Design Specifications	N/A

5.4 Washing of Equipment and Vehicles

General

- Construction equipment and vehicles shall be rinsed of dirt and debris before being stored or leaving the site.

Specific Pollution Prevention Practices

Washing of Equipment and Vehicles	
Description: • Construction vehicles shall be rinsed thoroughly of dirt and debris at the construction entrance before leaving the site. • Concrete trucks will wash out, or discharge surplus concrete or drum wash water, at the site in the staging area. Concrete pours will not be conducted during or before an anticipated storm event. Concrete mixer trucks and chutes will be washed in the designated area or concrete will be properly disposed of off-site. • A washout area will be constructed before concrete pours occur on the site, if required. It shall be lined with a plastic sheet (6 mils thick) free of any holes or tears. Signs shall be posted marking designated washout areas to ensure the concrete equipment operators use the proper facility. • Washing requiring soap or solvents shall be conducted in a tub, bucket, or barrier to contain contaminated water runoff. Wash water shall be discarded in the concrete washout station.	
Installation	Washout area will be installed before concrete is poured,
Maintenance Requirements	The washout area will be inspected daily to ensure all concrete washing is being discharges to the washout area, and no tears or leaks are present. When the temporary washout is full or no longer needed for the project, the hardened concrete be removed and disposed of legally.
Design Specifications	N/A

5.5 Storage, Handling, and Disposal of Building Products, Materials, and Wastes

5.5.1 Building Products

General

- All building products shall be stored under temporary cover.

Specific Pollution Prevention Practices

Building Products	
Description: Building products shall be covered with an impermeable barrier at the end of each working day.	
Installation	When necessary, as building products arrive.
Maintenance Requirements	• Materials shall be stored in a dry location, off the ground and in such manner as to prevent damage, and intrusion of foreign matter and weather. All materials which have become damaged or otherwise unfit for use during delivery or storage shall be replaced at the expense of the contractor.
Design Specifications	N/A

5.5.2 Pesticides, Herbicides, Insecticides, Fertilizers, and Landscape Materials

General

- Seed, fertilizer, mulch and water shall be mixed and applied to achieve application quantities specified. The use of Pesticides, Herbicides, and Insecticides is subject to the approval of the Engineer / Landscape Architect, and is to be handled by state-licensed operators only. Fertilizer quantity, gradation, and rate of application shall be determined based on soil tests and recommendations conducted by an approved soil testing laboratory. If this changes, it shall be requested in writing by the Contractor, approved in writing by the Landscape architect, and the SWPPP will be updated.

Specific Pollution Prevention Practices

Fertilizers, pesticides and herbicides control	
Description: Fertilizers, pesticides, herbicides shall not be used within 50 feet of any wetlands resource areas on this property. Fertilizers utilized for landscaping and lawn care in the outer Buffer Zone shall be organic and used sparingly.	
Installation	• Fertilizer shall not be applied outside the growing season, defined as April 15th to October 31st. No late season fertilization is allowed. • No fertilizer shall be applied during rainfall or before prediction of rain.
Maintenance Requirements	All fertilizers, herbicides and pesticides shall be stored off site or in a dry area that is protected from weather and secured to prevent children from obtaining access to them. Any major spills shall be reported to municipal officials.
Design Specifications	Order of Conditions.

5.5.3 Diesel Fuel, Oil, Hydraulic Fluids, Other Petroleum Products, and Other Chemicals

General

- Diesel fuel, oil, hydraulic fluids, other petroleum products and other chemicals shall not be stored on site. Truck beds shall be kept free of kerosene, gasoline, fuel, oil, solvents, or other materials.
- Contractor to provide off-site trucks to refuel on-site vehicles (backhoes, bulldozers, etc.).

Specific Pollution Prevention Practices

N/A	
Description: N/A	
Installation	N/A
Maintenance Requirements	N/A
Design Specifications	N/A

5.5.4 Hazardous or Toxic Waste

General

- Remove, haul from site, and legally dispose of all waste materials and debris not required to be saved. Accumulation is not permitted. Comply with all regulations regarding handling, storage, and disposal of all hazardous materials and waste. Consult local agencies or disposal companies for individual instructions and requirements. Improper disposal of paint and their related materials is illegal and may result in large fines. Please comply with all regulations and minimize waste whenever possible.

Specific Pollution Prevention Practices

Hazardous or Toxic Waste	
Description: The container storing hazardous and toxic materials shall be bolted, or chained to a permanent structure and shall be locking with separate keys. If this container itself is not weather tight and is exposed to the weather, it shall be covered with an impermeable barrier at the end of each working day.	
Installation	As Needed
Maintenance Requirements	• Maintain disposal routes clear, clean, and free of debris. • On-site burning of combustible cleared materials is not permitted. • Cover trucks used for hauling, follow approved routes, obtain disposal permits required and pay all fees in connection with disposal of materials removed. • Upon completion of site preparation work. Clean areas of work, remove tools and equipment. Provide site clear, clean, and free of materials and debris and suitable for site construction operations.
Design Specifications	N/A

5.5.5 Construction and Domestic Waste

General

- All waste materials will be collected and disposed of into metal trash dumpsters. Dumpsters will have a secure watertight lid, be placed away from stormwater conveyances and drains, and meet all federal, state, and municipal regulations. Only trash and construction debris from the site will be deposited in the dumpster. No construction materials will be buried on-site. All personnel will be instructed, during tailgate training sessions, regarding the correct disposal of trash and construction debris. Notices that state these practices will be posted in the office trailer and the individual who manages day-today site operations will be responsible for seeing that these practices are followed.

Specific Pollution Prevention Practices

Construction and Domestic Waste	
Description: Clean entire area daily. All trash and job related debris shall be removed from the site or stored in an approved dumpster at the contractor's discretion, unless otherwise specified by Town Official. The location of any dumpsters shall be coordinated with the school department. Dumpsters shall be covered at all times other than to provide adequate capacity for job related debris at all times.	
Installation	Prior to Start of Construction
Maintenance Requirements	Dumpsters shall be inspected twice per week and immediately after storm events. Remove waste material promptly from premises. Store material and equipment in dry location, in neat and orderly fashion. Ensure adequate security for electrical material and equipment stored at job.
Design Specifications	N/A

5.5.6 *Sanitary Waste*

General

- Portable sanitary units will be provided for use by all workers throughout the life of the project. A licensed sanitary waste management contractor will regularly collect all sanitary waste from the portable units.

Specific Pollution Prevention Practices

Sanitary Waste	
Description: Portable toilets will be self-contained units meeting local, State and Federal requirements.	
Installation	• Prior to Start of Construction • The Contractor shall provide adequate sanitary facilities for the use of those employed on the Work. Such facilities shall be made available when the first employees arrive on the Site of the Work, shall be properly secluded from public observation, and shall be constructed and maintained during the progress of the Work.
Maintenance Requirements	• Waste for the portable toilets shall be collected a minimum of once a week. The toilets shall be inspected weekly for sign of leaking. Toilets that are leaking shall be removed from the site and replaced. • The Contractor shall maintain the sanitary facilities in a satisfactory and sanitary condition at all times and shall enforce their use. He/she shall vigorously prohibit the committing of nuisance on the Site of the Work, on lands of the Owner, or an adjacent property.
Design Specifications	N/A

5.6 *Washing of Applicators and Containers used for Paint, Concrete or Other Materials*

General

- See section 5.4

Specific Pollution Prevention Practices

See section 5.4	
Description: See section 5.4	
Installation	See section 5.4
Maintenance Requirements	See section 5.4
Design Specifications	See section 5.4

5.7 *Fertilizers*

General

- The contractor shall provide all labor, materials, equipment and services necessary for, and incidental to, preparation of ground surfaces, fertilizing, liming, seeding, mulching, and maintenance of seeded areas as shown on the Drawings.

Specific Pollution Prevention Practices

Fertilizers	
Description: See Section 5.5.2.	
Installation	See Section 5.5.2
Maintenance Requirements	See Section 5.5.2.
Design Specifications	See Section 5.5.2.

5.8 Other Pollution Prevention Practices

General

- N/A

Specific Pollution Prevention Practices

N/A	
Description: N/A	
Installation	N/A
Maintenance Requirements	N/A
Design Specifications	N/A

SECTION 6: INSPECTION, MAINTENANCE, AND CORRECTIVE ACTION

6.1 Inspection Personnel and Procedures

Personnel Responsible for Inspections

Steve Thulin

Note: All personnel conducting inspections must be considered a "qualified person." CGP Part 4.1 clarifies that a "qualified person" is a person knowledgeable in the principles and practices of erosion and sediment controls and pollution prevention, who possesses the appropriate skills and training to assess conditions at the construction site that could impact stormwater quality, and the appropriate skills and training to assess the effectiveness of any stormwater controls selected and installed to meet the requirements of this permit.

Inspection Schedule

Select the inspection frequency(ies) that applies, based on CGP Parts 4.2, 4.3, or 4.4

(Note: you may be subject to different inspection frequencies in different areas of the site. Check all that apply)

Standard Frequency:
☐ Every 7 days ☒ Every 14 days and within 24 hours of a 0.25" rain or the occurrence of runoff from snowmelt sufficient to cause a discharge
Increased Frequency (if applicable):
For areas of sites discharging to sediment or nutrient-impaired waters or to waters designated as Tier 2, Tier 2.5, or Tier 3 ☒ Every 7 days and within 24 hours of a 0.25" rain
Reduced Frequency (if applicable)
For stabilized areas ☐ Twice during first month, no more than 14 calendar days apart; then once per month after first month; (Note: It is likely that you will not be able to include this in your initial SWPPP. If you qualify for this reduction (see CGP Part 4.4.1), you will need to modify your SWPPP to include this information.)
For stabilized areas on "linear construction sites" ☐ Twice during first month, no more than 14 calendar days apart; then once more within 24 hours of a 0.25" rain (Note: It is likely that you will not be able to include this in your initial SWPPP. If you qualify for this reduction (see CGP Part 4.4.1), you will need to modify your SWPPP to include this information.)
For arid, semi-arid, or drought-stricken areas during seasonally dry periods or during drought ☐ Once per month and within 24 hours of a 0.25" rain Insert beginning and ending dates of the seasonally-defined dry period for your area or the valid period of drought: ▪ Beginning date of seasonally dry period: 7/6/2020 ▪ Ending date of seasonally dry period: 9/7/2020

For frozen conditions where earth-disturbing activities are being conducted
☒ Once per month Insert beginning and ending dates of frozen conditions on your site: ▪ Beginning date of frozen conditions: NA ▪ Ending date of frozen conditions: NA

Inspection Report Forms

See Appendix D

- All area-drain, catch basins, drain manholes and other structures shall be inspected before and after construction. The condition of the structures shall be recorded.
- All stormwater control devices are to be inspected weekly (7 days) and within 24-hours of the occurrence of a storm even event of 0.25" depth or greater (even if the storm is still continuing.
- Litter and debris clean-up shall be performed daily.
- If a problem is observed with an erosion and sediment control (needs repair or replacement), work must be initiated immediately to fix the problem, and shall be completed by the end of the next work day. If the repair or replacement is more substantial, it shall be completed within 7 calendar days from the time of discovery. If a repair takes longer than 48-hours, the repair procedures should be documented and recorded.
- If discharge of stormwater is occurring during an inspection, the location and quality of the discharge shall be noted as well as the effectiveness of erosion and sediment controls.

Rain Gauge Location (if applicable)

N/A

(Note: EPA has developed a sample inspection form that CGP operators can use. The form is available at https://www.epa.gov/npdes/stormwater-discharges-construction-activities#resources)

6.2 Corrective Action

Personnel Responsible for Corrective Actions
See section 1.1

Corrective Action Forms
See Appendix E

(Note: EPA has developed a sample corrective action form that CGP operators can use. The form is available at https://www.epa.gov/npdes/stormwater-discharges-construction-activities#resources)

6.3 Delegation of Authority

Duly Authorized Representative(s) or Position(s):

Consigli Construction Company
72 Sumner St
Milford MA 01757

John LaMarre
617-293-5296
jlamarre@consigli.com

SECTION 7: TRAINING

Table 7-1: Documentation for Completion of Training

Name	Describe Training	Date Training Completed
INSERT NAME OF PERSONNEL		INSERT COMPLETION DATE
TBD		

SECTION 8: CERTIFICATION AND NOTIFICATION

Instructions (CGP Appendix I, Part I.11.b):

– The following certification statement must be signed and dated by a person who meets the requirements of Appendix I, Part I.11.b.
– This certification must be re-signed in the event of a SWPPP Modification.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I have no personal knowledge that the information submitted is other than true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Name: John LaMarre Title: Senior Project Manager

Signature: ____________________ Date: 03/30/20

SWPPP APPENDICES

Attach the following documentation to the SWPPP:

Appendix A – Site Maps

Appendix B – Copy of 2017 CGP
(Note: The 2017 CGP is available at https://www.epa.gov/npdes/epas-2017-construction-general-permit-cgp-and-related-documents)

Appendix C – NOI and EPA Authorization Email

Appendix D – Inspection Form
(Note: EPA has developed a sample inspection form that CGP operators can use. The form is available at https://www.epa.gov/npdes/stormwater-discharges-construction-activities#resources)

Appendix E – Corrective Action Form
(Note: EPA has developed a sample corrective action form that CGP operators can use. The form is available at https://www.epa.gov/npdes/stormwater-discharges-construction-activities#resources)

Appendix F – SWPPP Amendment Log

Appendix G – Subcontractor Certifications/Agreements

Appendix H – Grading and Stabilization Activities Log

Appendix I – Training Log

Appendix J – Delegation of Authority

Appendix K – Endangered Species Documentation

Appendix L – Historic Preservation Documentation

Appendix A – Site Maps

Under separate cover

Appendix B – Copy of 2017 CGP

Insert copy of the CGP.

(Note: The 2017 CGP is available at https://www.epa.gov/npdes/epas-2017-construction-general-permit-cgp-and-related-documents)

Appendix C – Copy of NOI and EPA Authorization email

INSERT COPY OF NOI AND EPA'S AUTHORIZATION EMAIL PROVIDING COVERAGE UNDER THE CGP

LaMarre, John

From: NPDES, GeneralPermits <Npdes.Generalpermits@epa.gov>
Sent: Tuesday, March 17, 2020 4:07 PM
To: LaMarre, John
Cc: William Burns; catherine.vakalopoulos@state.ma.us; achapdelaine@town.arlington.ma.us; PubWorks@town.arlington.ma.us
Subject: RE: Arlington High School - RGP NOI
Attachments: MAG910911_Authorization_signed.pdf

Good afternoon,

Attached, please find the written authorization to discharge under the Remediation General Permit (RGP) for the referenced site.

Please let me or Shauna Little (little.shauna@epa.gov) know if you have any questions or concerns.

Best,
Michelle Vuto
Stormwater & Construction Permits
U.S. EPA Region 1
5 Post Office Square (06-4)
Boston, MA 02109-3912
617-918-1222

From: William Burns <wb@mcphailgeo.com>
Sent: Monday, March 02, 2020 12:43 PM
To: NPDES, GeneralPermits <Npdes.Generalpermits@epa.gov>
Subject: RE: Arlington High School - RGP NOI

Thank you, Shauna.

Bill Burns, L.S.P., L.E.P.

McPHAIL ASSOCIATES, LLC
617-868-1420 Ext. 341

From: Little, Shauna [mailto:Little.Shauna@epa.gov] **On Behalf Of** NPDES, GeneralPermits
Sent: Monday, March 02, 2020 12:42 PM
To: William Burns <wb@mcphailgeo.com>; NPDES, GeneralPermits <Npdes.Generalpermits@epa.gov>
Cc: Lori Cowles <lcowles@hmfh.com>; Jonathan Patch <JWP@mcphailgeo.com>; Christopher P. Miller <CMiller@mcphailgeo.com>; jlamarre@consigli.com
Subject: RE: Arlington High School - RGP NOI

EPA received the NOI and it will be reviewed shortly.

Regards,

Shauna Little
Physical Scientist
Water Division
U.S. EPA Region 1
Phone: (617) 918-1989

From: William Burns <wb@mcphailgeo.com>
Sent: Monday, March 02, 2020 10:52 AM
To: NPDES, GeneralPermits <Npdes.Generalpermits@epa.gov>
Cc: catherine.vakalopoulos@state.ma.us; Lori Cowles <lcowles@hmfh.com>; Jonathan Patch <JWP@mcphailgeo.com>; Christopher P. Miller <CMiller@mcphailgeo.com>; jlamarre@consigli.com
Subject: Arlington High School - RGP NOI

To Whom it May Concern,

For your approval, attached is a copy of the Notice of Intent for Discharge under the MA Remediation General Permit for the upcoming construction activities associated with the new Arlington High School project . In addition, attached is the MA Limit Book working spreadsheets which were utilized as part of our evaluation of discharge limitations. Please let me know if you have any questions or require any additional information. Thank you.

-Bill

William J. Burns, L.S.P., L.E.P.

McPHAIL ASSOCIATES, LLC
2269 Massachusetts Avenue
Cambridge, MA 02140
Tel: 617-868-1420 ext. 341
Direct: 617-349-7341
www.mcphailgeo.com

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 1
5 Post Office Square, Suite 100
Boston, MA 02109-3912

VIA EMAIL

March 17, 2020

John LaMarre
Consigli Construction Co., Inc.
72 Sumner Street
Milford, MA 01757
JLaMarre@consigli.com

Re: Authorization to discharge under the Remediation General Permit (RGP) Œ Authorization #MAG910911 for the Arlington High School site located at 869 Massachusetts Ave in Arlington, MA

Dear John LaMarre:

Based on the review of a Notice of Intent (NOI) received March 2, 2020 submitted by McPhail Associates, LLC for the site referenced above, the U.S. Environmental Protection Agency, Region 1 (EPA) hereby authorizes Consigli Construction Co., Inc., as the named operator, to discharge in accordance with the provisions of the RGP from this site via the Town of Arlington storm sewer system to the Mill Brook (MA71-07). Please note that the operator is responsible for obtaining permission to discharge to this system, prior to initiating discharges. EPA™s authorization to discharge does not convey any such permission. The authorization number is listed above. The effective date of coverage is the date of this authorization letter. The RGP and this authorization to discharge will expire on April 8, 2022, or upon Notice of Termination, whichever occurs first. In accordance with Part 5.3 of the RGP, your permit coverage will be administratively continued upon expiration if the RGP has not been reissued.

Enclosed with this RGP authorization to discharge is a summary of the applicable effluent limitations and monitoring requirements for your activity category III, contaminated site dewatering discharge. Where a given parameter does not apply to the discharge, EPA has indicated fiNot Requiredfl in the enclosed summary. A dilution factor of 1.79, approved by the Massachusetts Department of Environmental Protection, was used in calculating effluent limits applicable to the proposed discharge from this site, except for parameters for which the receiving water is impaired, if applicable. Please note that this summary does not represent the complete requirements of the RGP. Operators must comply with all of the applicable requirements of the RGP, including influent and effluent monitoring, record keeping, and reporting requirements. For the complete general permit, see EPA™s RGP website, currently available at: https://www.epa.gov/npdes-permits/remediation-general-permit-rgp-massachusetts-new-hampshire.

Your authorization to discharge includes a technology-based effluent limit for cyanide because

you disclosed that this parameter is present at the site.

Monitoring requirements begin upon initiation of discharge. Please ensure that sufficiently sensitive test methods are used for all sample analyses conducted for this permit. To be considered sufficiently sensitive, test methods must achieve a minimum level (ML) for analysis for a given parameter that is no greater than the effluent limitation for that parameter, unless otherwise specified for that parameter. Where no effluent limitation applies, EPA has provided the ML required with the enclosed summary. Where a compliance level applies, EPA has provided the required compliance level with the enclosed summary. See Part 4.1, 4.3, and 4.4 of the RGP for more information regarding monitoring requirements. Also see Appendix VII for more information regarding sufficiently sensitive test methods.

You must submit a Notice of Termination (NOT) within thirty (30) days of the termination of discharges, which must include an electronic attachment in accordance with Appendix VIII of all monitoring data collected. Since you have reported your discharges are expected to last twelve (12) months or more, EPA expects you will be subject to NetDMR reporting requirements. You must begin submitting monitoring data using NetDMR for the monitoring period beginning on April 1, 2021. See Parts Parts 4.6, 5.1, 5.2 and 6, Appendix IV, and Appendix VIII of the RGP for more information regarding reporting requirements. For additional Appendix VIII resources, including instructions for establishing a NetDMR account, see EPA™s RGP website noted above.

Thank you in advance for your cooperation in this matter. Please contact Shauna Little at (617) 918-1989 or little.shauna@epa.gov, if you have any questions.

Sincerely,

Suzanne Warner, Acting Chief
Stormwater & Construction Permits Section
Water Division

cc: Adam Chapdelaine,Town of Arlington, via email
Bill Burns, McPhail Associates, LLC, via email
Cathy Vakalopoulos, MassDEP, via email
Town of Arlington DPW, via email

Table 1: Authorization Information

Permit Number	MAG910911
Receiving Water	Mill Brook
Outfall Number	Outfall 001 to Town of Arlington
Monitoring Requirements	See Table 2 through Table 6, below; See Parts 4.1, 4.3 and 4.4 of the RGP; WET testing not required
Reporting Requirement	See Parts 4.6, 5.1, 5.2 and 6 of the RGP; NetDMR reporting will begin April 1, 2021 unless NOT received by EPA

Table 2: Chemical-Specific Effluent Limitations and Monitor-Only Requirements[1]

Parameter	Effluent Limitation[2]
A. Inorganics	
Ammonia[3]	Report mg/L
Chloride[4]	Report µg/L
Total Residual Chlorine[5]	Not Required
Total Suspended Solids	30 mg/L
Antimony[6]	206 µg/L
Arsenic[6]	104 µg/L
Cadmium[6]	10.2 µg/L
Chromium III[6]	323 µg/L
Chromium VI[6]	20.5 µg/L
Copper[6]	242 µg/L
Iron[6]	5,000 µg/L
Lead[6]	160 µg/L
Mercury[6]	0.739 µg/L
Nickel[6]	1,450 µg/L
Selenium[6]	235.8 µg/L
Silver[6]	35.1 µg/L
Zinc[6]	420 µg/L
Cyanide[7]	178 mg/L
B. Non-Halogenated Volatile Organic Compounds	
Total BTEX	Not Required
Benzene	Not Required
1,4 Dioxane	Not Required
Acetone	Not Required
Phenol	Not Required
C. Halogenated Volatile Organic Compounds	

Carbon Tetrachloride	Not Required
1,2 Dichlorobenzene	Not Required
1,3 Dichlorobenzene	Not Required
1,4 Dichlorobenzene	Not Required
1,1 Dichloroethane	Not Required
1,2 Dichloroethane	Not Required
1,1 Dichloroethylene	Not Required
Ethylene Dibromide	Not Required
Methylene Chloride	Not Required
1,1,1 Trichloroethane	Not Required
1,1,2 Trichloroethane	Not Required
Trichloroethylene	5.0 µg/L
Tetrachloroethylene	5.0 µg/L
cis-1,2 Dichloroethylene	70 µg/L
Vinyl Chloride	2.0 µg/L
D. Non-Halogenated Semi-Volatile Organic Compounds	
Total Phthalates	Not Required
Diethylhexyl Phthalate	Not Required
Total Group 1 Polycyclic Aromatic Hydrocarbons[8]	Not Required
Benzo(a)anthracene[8]	Not Required
Benzo(a)pyrene[8]	Not Required
Benzo(b)fluoranthene[8]	Not Required
Benzo(k)fluoranthene[8]	Not Required
Chrysene[8]	Not Required
Dibenzo(a,h)anthracene[8]	Not Required
Indeno(1,2,3-cd)pyrene[8]	Not Required
Total Group II Polycyclic Aromatic Hydrocarbons	100 µg/L
Naphthalene	20 µg/L
E. Halogenated Semi-Volatile Organic Compounds	
Total Polychlorinated Biphenyls[9]	Not Required
Pentachlorophenol	Not Required
F. Fuels Parameters	
Total Petroleum Hydrocarbons	5.0 mg/L
Ethanol	Not Required
Methyl-tert-Butyl Ether	Not Required
tert-Butyl Alcohol	Not Required
tert-Amyl Methyl Ether	Not Required

Table 2 Notes:

[1] The following abbreviations are used in Table 2, above:

[a] mg/L = milligrams per liter

[b] µg/L = micrograms per liter

[2] The limitation type for all parameters is monthly average.

[3] The minimum level (ML) for analysis of ammonia must be less than or equal to 0.1 mg/L.

[4] The ML for analysis of chloride must be less than or equal to 230 mg/L.

[5] The ML for analysis of total residual chlorine (TRC) must be less than or equal to 50 µg/L.

[6] The limitation for this parameter is on the basis of total recoverable metal in the water column.

[7] Total cyanide must be reported. The ML for analysis of total cyanide must be less than or equal to 5.0 µg/L. The compliance level for total cyanide is 5.0 µg/L.

[8] The ML for analysis of group I polycyclic aromatic hydrocarbons (PAHs) must be less than or equal to 0.1 µg/L.

[9] The ML for analysis of total polychlorinated biphenyls (PCBs) must be less than or equal to 0.5 µg/L.

Table 3: Effluent Flow Limitation[1]

Effluent Flow	Effluent Limitation[2]
	0.144

Table 3 Notes

[1] The following abbreviations are used in Table 3, above:

[a] MGD = million gallons per day

[2] The limitation type for effluent flow is daily maximum.

Table 4: pH Limitations[1]

Receiving Water Class	Effluent Limitation[2]
Freshwater	6.5 to 8.3 SU

Table 4 Notes

[1] The following abbreviations are used in Table 4, above:

[a] SU = standard units

[2] The limitation type for pH is range.

Table 5: Temperature Limitations[1]

Receiving Water Class		Effluent Limitation[2]	ΔT Limitation [3]
Class B	---	Not Required	Not Required

Table 5 Notes

[1] The following abbreviations are used in Table 5, above:

[a] ^{o}F = degrees Fahrenheit

[b] ΔT = change in temperature

[c] ≤ = less than or equal to

[2] The limitation type for temperature is daily maximum.

[3] Change in temperature from background shall be determined by subtracting the temperature of the effluent from the temperature of the receiving water measured at a point immediately upstream of a discharge's zone of influence at a reasonably accessible location

Table 6: Additional Requirements[1]

Parameter[2]	Effluent Limitation [3]
None Required	NA

Table 6 Notes

[1] The following abbreviations are used in Table 6, above:

[a] NA = not applicable

[2] NA

[3] NA

Appendix D – Copy of Inspection Form

INSERT COPY OF ANY INSPECTION FORMS YOU WILL USE TO PREPARE INSPECTION REPORTS

(Note: EPA has developed a sample inspection form that CGP operators can use. The form is available at https://www.epa.gov/npdes/stormwater-discharges-construction-activities#resources)

Appendix E – Copy of Corrective Action Form

INSERT COPY OF CORRECTIVE ACTION FORMS YOU WILL USE

(Note: EPA has developed a sample corrective action form that CGP operators can use. The form is available at https://www.epa.gov/npdes/stormwater-discharges-construction-activities#resources)

Appendix F – *Sample* SWPPP Amendment Log

No.	Description of the Amendment	Date of Amendment	Amendment Prepared by [Name(s) and Title]
		INSERT DATE	
		INSERT DATE	
		INSERT DATE	
		INSERT DATE	
		INSERT DATE	
		INSERT DATE	
		INSERT DATE	
		INSERT DATE	

Appendix G – *Sample* Subcontractor Certifications/Agreements

SUBCONTRACTOR CERTIFICATION
STORMWATER POLLUTION PREVENTION PLAN

Project Number: ____

Project Title: Arlington High School

Operator(s): ____

As a subcontractor, you are required to comply with the Stormwater Pollution Prevention Plan (SWPPP) for any work that you perform on-site. Any person or group who violates any condition of the SWPPP may be subject to substantial penalties or loss of contract. You are encouraged to advise each of your employees working on this project of the requirements of the SWPPP. A copy of the SWPPP is available for your review at the office trailer.

Each subcontractor engaged in activities at the construction site that could impact stormwater must be identified and sign the following certification statement:

I certify under the penalty of law that I have read and understand the terms and conditions of the SWPPP for the above designated project and agree to follow the practices described in the SWPPP.

This certification is hereby signed in reference to the above named project:

Company: ____

Address: ____

Telephone Number: ______________________

Type of construction service to be provided: ______________________________

____

____

Signature: ______________________

Title: ______________________

Date: ______________________

Appendix H – *Sample* Grading and Stabilization Activities Log

Date Grading Activity Initiated	Description of Grading Activity	Description of Stabilization Measure and Location	Date Grading Activity Ceased (Indicate Temporary or Permanent)	Date When Stabilization Measures Initiated
INSERT DATE			INSERT DATE ☐ Temporary ☐ Permanent	INSERT DATE
INSERT DATE			INSERT DATE ☐ Temporary ☐ Permanent	INSERT DATE
INSERT DATE			INSERT DATE ☐ Temporary ☐ Permanent	INSERT DATE
INSERT DATE			INSERT DATE ☐ Temporary ☐ Permanent	INSERT DATE
INSERT DATE			INSERT DATE ☐ Temporary ☐ Permanent	INSERT DATE
INSERT DATE			INSERT DATE ☐ Temporary ☐ Permanent	INSERT DATE
INSERT DATE			INSERT DATE ☐ Temporary ☐ Permanent	INSERT DATE
INSERT DATE			INSERT DATE ☐ Temporary ☐ Permanent	INSERT DATE

Appendix I – *Sample* SWPPP Training Log

Stormwater Pollution Prevention Training Log

Project Name: **Arlington High School**

Project Location: **869 Massachusetts Ave, Arlington MA 02476**

Instructor's Name(s):

Instructor's Title(s):

Course Location: ______________________________ Date: ________________

Course Length (hours): __________________________

Stormwater Training Topic: *(check as appropriate)*

- ☐ **Sediment and Erosion Controls**
- ☐ **Stabilization Controls**
- ☐ **Pollution Prevention Measures**
- ☐ **Emergency Procedures**
- ☐ **Inspections/Corrective Actions**

Specific Training Objective:____

____

Attendee Roster: *(attach additional pages as necessary)*

No.	Name of Attendee	Company
1		
2		
3		
4		
5		
6		
7		
8		

Appendix J – *Sample* Delegation of Authority Form

Delegation of Authority

I, ________________________ (name), hereby designate the person or specifically described position below to be a duly authorized representative for the purpose of overseeing compliance with environmental requirements, including the Construction General Permit (CGP), at the ______________________________________ construction site. The designee is authorized to sign any reports, stormwater pollution prevention plans and all other documents required by the permit.

____ (name of person or position)
____ (company)
____ (address)
____ (city, state, zip)
____ (phone)

By signing this authorization, I confirm that I meet the requirements to make such a designation as set forth in Appendix I of EPA's CGP, and that the designee above meets the definition of a "duly authorized representative" as set forth in Appendix I.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I have no personal knowledge that the information submitted is other than true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Name: ____

Company: ____

Title: ____

Signature: ____

Date: ____

Appendix K – Endangered Species Documentation

INSERT DOCUMENTATION CONSISTENT WITH SWPPP TEMPLATE SECTION 3.1 AND CGP APPENDIX D

Appendix L – Historic Properties Documentation

INSERT DOCUMENTATION CONSISTENT WITH SWPPP TEMPLATE SECTION 3.2 AND CGP APPENDIX E

Appendix M – Rainfall Gauge Recording

Use the table below to record the rainfall gauge readings at the beginning and end of each work day. An example table follows.

Month/Year			Month/Year			Month/Year		
Day	Start time	End time	Day	Start time	End time	Day	Start time	End time
1			1			1		
2			2			2		
3			3			3		
4			4			4		
5			5			5		
6			6			6		
7			7			7		
8			8			8		
9			9			9		
10			10			10		
11			11			11		
12			12			12		
13			13			13		
14			14			14		
15			15			15		
16			16			16		
17			17			17		
18			18			18		
19			19			19		
20			20			20		
21			21			21		
22			22			22		
23			23			23		
24			24			24		
25			25			25		
26			26			26		
27			27			27		
28			28			28		
29			29			29		
30			30			30		
31			31			31		

Example Rainfall Gauge Recording

April 2017			May 2017			June 2017		
Day	7:00 am	4:400 pm	Day	7:00 am	4:00 pm	Day	7:00 am	4:00 pm
1	--	--	1	0.2	0	1	0	0.4
2	--	--	2	0	0	2	0	0
3	0	0	3	0.1	0.3	3	--	--
4	0	0.3	4	0	0	4	--	--
5	0	0	5	0	0	5	0	0

In this example (for only partial months), 0.25-inch rainfall inspections would have been conducted on April 4 and June 1.

NOTICE OF INTENT FOR DISCHARGE PURSUANT TO MASSACHUSETTS REMEDIATION GENERAL PERMIT MAG9100000

ARLINGTON HIGH SCHOOL
ARLINGTON, MASSACHUSETTS

FEBRUARY 24, 2020

Prepared For:
United States Environmental Protection Agency
Office of Ecosystem Protection
5 Post Office Square, Suite 100
Mail Code OEP06-01
Boston, MA 02109-3912

On Behalf Of:

Consigli Construction Co. Inc.
72 Sumner Street
Milford, MA 01757

PROJECT NO. 6531

McPHAIL ASSOCIATES, LLC
2269 Massachusetts Avenue
Cambridge, MA 02140
www.mcphailgeo.com
(617) 868-1420

February 24, 2020

United States Environmental Protection Agency
Office of Ecosystem Protection
5 Post Office Square, Suite 100
Mail Code OEP06-01
Boston, MA 02109-3912

Attention: EPA RGP Applications Coordinator

Reference: Arlington High School; 869 Massachusetts Avenue, Arlington, MA;
Notice of Intent for Temporary Construction Dewatering Discharge;
Massachusetts Remediation General Permit MAG910000

Ladies and Gentlemen:

On behalf of Consigli Construction Co., Inc., McPhail Associates, LLC (McPhail) has prepared the attached Notice of Intent (NOI) for coverage under the Remediation General Permit (RGP) MAG910000 for the discharge of construction dewatering effluent into the Mill Brook which flows into the Lower Mystic Lake via the on-site storm drainage system. The temporary construction dewatering discharge will occur during redevelopment of the Arlington High School located at 869 Massachusetts Avenue in Arlington, Massachusetts (project site). Refer to **Figure 1** for the general site locus.

These services were performed and this permit application was prepared in accordance with the authorization of HMFM Architects, Inc. These services are subject to the limitations contained in **Appendix A**.

This project is considered Activity Category III-G as defined in the RGP. Category III-G is defined as Contaminated Site Dewatering from Sites with Known Contamination. Based on historical and current soil and groundwater analysis completed at the site, the constituents of concern (COCs) are those identified under subcategory A (Inorganics), subcategory C (halogenated VOCs), subcategory D (non-halogenated SVOCs), and subcategory F (fuel parameters). The required Notice of Intent (NOI) Form contained in the RGP permit is included in **Appendix B**.

Applicant/Operator

The applicant for the Notice of Intent-Remediation General Permit is:

Consigli Construction Co., Inc.
72 Sumner Street
Milford, MA 01757

Attention: Mr. John LaMarre; Senior Project Manager

Existing Conditions

Fronting onto Massachusetts Avenue to the south, the approximately 22-acre Arlington High School campus is bounded by the Arlington Department of Public Works (DPW) facility and residential properties to the west, the Minuteman Commuter Bikeway with residential properties on the other side thereof to the north, and to the east by residential and commercial properties. The existing school complex is located near the center of the campus and is surrounded by athletic fields, asphalt paved parking lots and landscaped areas. The remaining exterior portions of the site are occupied by a grassed area located along Massachusetts Avenue, a playground and basketball courts located adjacent to the northeast of the school complex as well as parking lots and driveways that connect to Millbrook Drive to the east and Massachusetts Avenue to the south. The existing conditions of the Arlington High School campus are shown on **Figure 2**.

Existing ground surface to the south of the existing school complex generally slopes downward from south to north from about Elevation +77 to Elevation +68. Within the northern portion of the campus, a majority of which is occupied by athletic fields, the existing grade gradually slopes from west to east from approximately Elevation +54 to about Elevation +45.

Proposed Scope of Site Development

The Arlington High School project includes the phased construction of a new school building in conjunction with phased demolition of the existing school building. The new school building will generally consist of four "wings" ranging from three to five stories which are connected by a central spine with a total plan area of approximately 145,900 square-feet. Additional site improvements will include the construction of parking lots, driveways, new athletic fields as well as a geothermal well field. In general, the proposed ground surface elevations and finish floor elevations will be higher than those currently existing across the school campus.

Site Environmental Setting and Surrounding Historical Places

Based on an on-line edition of the Massachusetts Geographic Information Systems MassDEP MCP Numerical Ranking System Map, the project site is not located within the boundaries of a Sole Source Aquifer, Potentially Productive Aquifer or within a Zone II, Interim Wellhead Protection Area as defined by the Massachusetts Department of Environmental Protection. Further, there are no public drinking water supply wells, no Areas of Critical Environmental Concern, no fish habitats, no habitats of Species of Special Concern or Threatened or Endangered Species within specified distances of the project site. No areas designated as solid waste facilities (landfills) are located within 0.5 miles of the subject site. A culverted portion of the Mill Brook traverses beneath the northern portion of the project site. The Mill Brook is classified by the DEP as a Class B surface water body and flows in a northeasterly direction into the Lower Mystic Lake. A copy of the Massachusetts DEP Phase I Site Assessment Map is included in **Appendix C**.

A review of information provided by the U.S. Fish and Wildlife Service in an Information for Planning and Conservation (IPaC) Trust Resource Report for the project site did not identify the presence of threatened or endangered species at or in the vicinity of the discharge location and/or discharge outfall. Further, the Trust Resource Report did not identify the presence of a critical habitat in the vicinity of the discharge outfall and/or discharge location. Based upon the above, the site is considered a criterion A pursuant to Appendix IV of the RGP. A copy of the IPaC Trust Resource Report and U.S. Fish and Wildlife Service's Nationwide Standard Conservation Measures are included in **Appendix C**.

As further discussed below, treated construction dewatering effluent will be discharged into the Mill Brook that flows into the Lower Mystic Lake. The dewatering of groundwater at the site will be temporary and intermittent. Groundwater discharged as part of the proposed project will be controlled and monitored. Treatment systems will consist of temporary structures. Therefore, based on the anticipated duration of construction dewatering and the location of its discharge into the Mill Brook, construction dewatering activities are not anticipated to affect historical listings. Hence, the site meets Permit Eligibility Criterion A in accordance with Appendix III of the RGP.

Site & Release History

Prior to its construction, the school campus consisted of undeveloped land. During this time period, the northern portion of the campus was occupied by Cutter's Mill Pond which was fed by Mill Brook. In 1908, the pond was drained and the area was backfilled over the next 20 years using soils and wastes from the former industrial sites that occupied the neighboring properties. Backfilling of the pond was completed by 1930, and the area was converted into a playground and playing field.

Historical records indicate that the project site was initially developed in 1914 with the construction of the 6-story Fusco Building (southwestern portion of the current school complex). Subsequently, from 1938 through 1981 the phased construction of the remaining buildings of the school complex were completed. During this time period, portions of the school complex were formerly heated by fuel oil that was stored within underground storage tanks (USTs) located to the north of the Collomb House and Downs House.

In summary, the former industrial and commercial use of surrounding properties has contaminated soil and groundwater across the project site. In addition, localized areas of soil have been contaminated by fuel oil that was stored in USTs and formerly used to heat the school complex. These releases of contamination have been documented with the DEP under Release Tracking Numbers (RTNs) 3-4241, 3-22352, 3-22371, 3-24460 and 3-30236.

In particular, soil and groundwater across the northern portion of the project site is contaminated by a release of hexavalent chromium, polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), petroleum hydrocarbons, lead and cyanide to which the DEP has assigned RTN 3-4241. In 2005, significant response actions were completed across the northern portion of the project site to mitigate exposure to soil and

groundwater that was contaminated by hexavalent chromium. Currently, the RTN 3-4241 site is being managed under the Remedy Operation Status provisions of the MCP.

Soil and groundwater at the southern portion of the project site is affected by a release of tetrachloroethene (PCE) to which RTN 3-30236 was assigned by the DEP. The release of PCE has migrated onto the site with the north-northeasterly direction of groundwater from a former off-site drycleaners located on the opposite side of Massachusetts Avenue.

Furthermore, soil and groundwater located beneath a portion of the Collomb House was affected by a waste oil release to which RTN 3-24460 was assigned by the DEP. The waste oil release was identified during the removal of a UST from beneath the former automotive shop that was located in the basement of the Collomb House. Petroleum constituents as well as PCE was identified in soil and groundwater within the UST grave. While response actions included the removal of contaminated soil, post remedial testing of soil samples from the vicinity of the excavation identified elevated levels of PCE. A Class A-2 Response Action Outcome Statement (Permanent Solution) was filed with the DEP for RTN 3-24460 site.

Construction Site Dewatering

Given its potential to mobilize contamination that is present in soil and groundwater, on-site recharge of dewatered groundwater is not considered feasible at the project site. In general, the depth of excavation required to install the proposed building foundation elements and subsurface utilities will not encounter groundwater, the surface of which ranges from about Elevation +46.7 at the northern portion of the project site to about Elevation +38.3 at the southern portion of the project site. However, there may be localized areas of excavation that may encounter groundwater and hence require dewatering. If required, the rate of construction dewatering within these localized areas of excavation may range from approximately 25 to 50 gallons per minute (gpm). These estimates do not include surface run-off which will be removed from the excavation during periods of precipitation.

However, it is anticipated that excess groundwater will be generated during the drilling of the geothermal boreholes that will require off-site discharge. Although difficult to estimate, the rate of excess groundwater generated during the drilling of the geothermal boreholes may range from 75 to 100 gpm.

Catch basins and associated stormwater drains located on the Arlington High School Campus connect to the Mill Brook culvert which traverses the northern portion of the project site. As mentioned above, Mill Brook eventually flows into the Lower Mystic Lake which is located approximately 0.65 miles to the northeast of the project site. The flow path of the discharge is shown on **Figure 2**.

Summary of Groundwater Analysis

On December 23, 2019, McPhail Associates, LLC obtained a sample of groundwater from monitoring well GP-108 (OW) located within the interior courtyard of the school complex. Additionally, on December 24, McPhail obtained a groundwater sample from monitoring well MW-04-5 located adjacent to the baseball field which occupies the western side of the school campus. The groundwater samples were submitted to a certified laboratory for analysis for the presence of compounds required under the EPA's Remediation General Permit (RGP) application, including total suspended solids (TSS), total residual chlorine, total petroleum hydrocarbons (TPH), volatile organic compounds (VOCs) including total benzene, toluene, ethylbenzene and xylenes (BTEX), poly-aromatic hydrocarbons (PAHs), total phenols, PCBs, and total recoverable metals. Additionally, previous groundwater testing was completed to further evaluate the presence of VOCs at the southern portion of the project site as well as extractable petroleum hydrocarbons (EPH) and volatile petroleum hydrocarbons (VPH) near a UST located beneath the courtyard of the school complex. The results of the laboratory analysis are summarized in **Table 1**, and laboratory data reports are included in **Appendix D**.

Pursuant to Section 4.2.2 of the EPA 2017 RGP, a receiving water sample was obtained from the Mill Brook (42° 25′ 12″ N, 71° 09′ 50″ W), which is located approximately 240 feet upstream of the discharge location on January 8, 2020. The receiving water sample was analyzed for the presence of total recoverable metals, pH, and hardness. The results of the surface water testing are summarized on **Table 2** and the laboratory data report is included in the enclosed **Appendix E**.

A Dilution Factor (DF) was calculated for the detected levels of metals pursuant to the procedure contained in RGP MAG910000, Appendix V. The purpose of the DF calculation is to establish Total Recoverable Limits for metals, taking into consideration the anticipated dilution of the detected analyte upon discharge into the Mill Brook. The calculated DF was then used to find the appropriate Dilution Range Concentrations (DRCs) contained in MAG910000, Appendix IV. The Minimum Flow Rate calculated by the USGS Streamstats GIS database at the location of discharge into the Mill Brook for 7 consecutive days with a recurrence interval of 10 years (7Q10 flow) is 0.114 MGD thus resulting in a DF of 1.79 assuming a design flow rate of 100 GPM.

With the exception of hexavalent chromium, the results of the laboratory testing did not detect concentrations of the tested compounds which triggered Water Quality-Based Effluent Limitations (WQBELs). It is noted that the concentrations of trivalent chromium, naphthalene, trichlroroethene, tetrachlorothene and total petroleum hydrocarbons did not exceed applicable MCP reporting thresholds established in Appendix VI of the RGP. Documentation of NOI support calculations is included in **Appendix C**.

Although trivalent chromium, naphthalene, trichlroroethene, tetrachlorothene and total petroleum hydrocarbons were not detected at concentrations which exceed the applicable Technology Based Effluent Limitations (TBELs), these compounds have been identified as contaminants of concern in soil and groundwater at the project site. As a result, these

compounds are considered to be potentially present in the construction dewatering effluent. It is anticipated that the construction dewatering treatment system that is discussed below, which includes granular activated carbon and ion resin filtration will reduce potential concentrations of the above referenced contaminants of concern in the effluent to below the applicable TBELs.

In accordance with the RGP, and given that the project site is an MCP site, the proposed dewatering associated with this permit application is considered Contaminated Site Dewatering from Sites with Known Contamination (Category III-G). Based on historical and current groundwater analysis completed at the site and the constituents of concern (COCs) detected, subcategory A (Inorganics), subcategory C (halogenated VOCs), subcategory D (non-halogenated SVOCs), and subcategory F (fuel parameters) apply to the discharge.

Groundwater Treatment

Based upon the anticipated rates of construction dewatering in conjunction with the results of the above referenced groundwater analyses, it is our opinion that one 10,000-gallon capacity settling tank, bag filters, a granular activated carbon (GAC) filter, and ion resin exchange filter in series will be necessary to settle out and remove particulate matter as well as to remove potential chlorinated solvents and metals in effluent to meet the limits established by the US EPA prior to off-site discharge. A schematic of the treatment system is shown on **Figure 3**.

A Best Management Practices Plan (BMPP) has been prepared as **Appendix F** to the RGP and will be posted at the site during the time period that temporary construction dewatering is occurring at the site.

Summary and Conclusions

The purpose of this report is to summarize site environmental conditions and groundwater data to support a Notice of Intent to discharge under the Remediation General Permit for the off-site discharge of dewatered groundwater which will be encountered during redevelopment of the Arlington High School campus that is located at the 869 Massachusetts Avenue in Arlington, Massachusetts. The groundwater testing results reported in this application have been provided to the site owner.

Based on the results of the above referenced groundwater analyses, treatment of construction dewatering will be necessary to meet the effluent limits established by the US EPA prior to off-site discharge. The proposed construction dewatering effluent treatment system will consist of one 10,000-gallon capacity settling tank, bag filters, a granular activated carbon (GAC) filter and ion exchange resin filter in series. However, should the effluent monitoring results identify concentrations of contaminants that are in excess of the limits established by the RGP, additional mitigative measures will be implemented to meet the allowable discharge limits.

We trust that the above satisfies your present requirements. Should you have any questions or comments concerning the above, please do not hesitate to contact us.

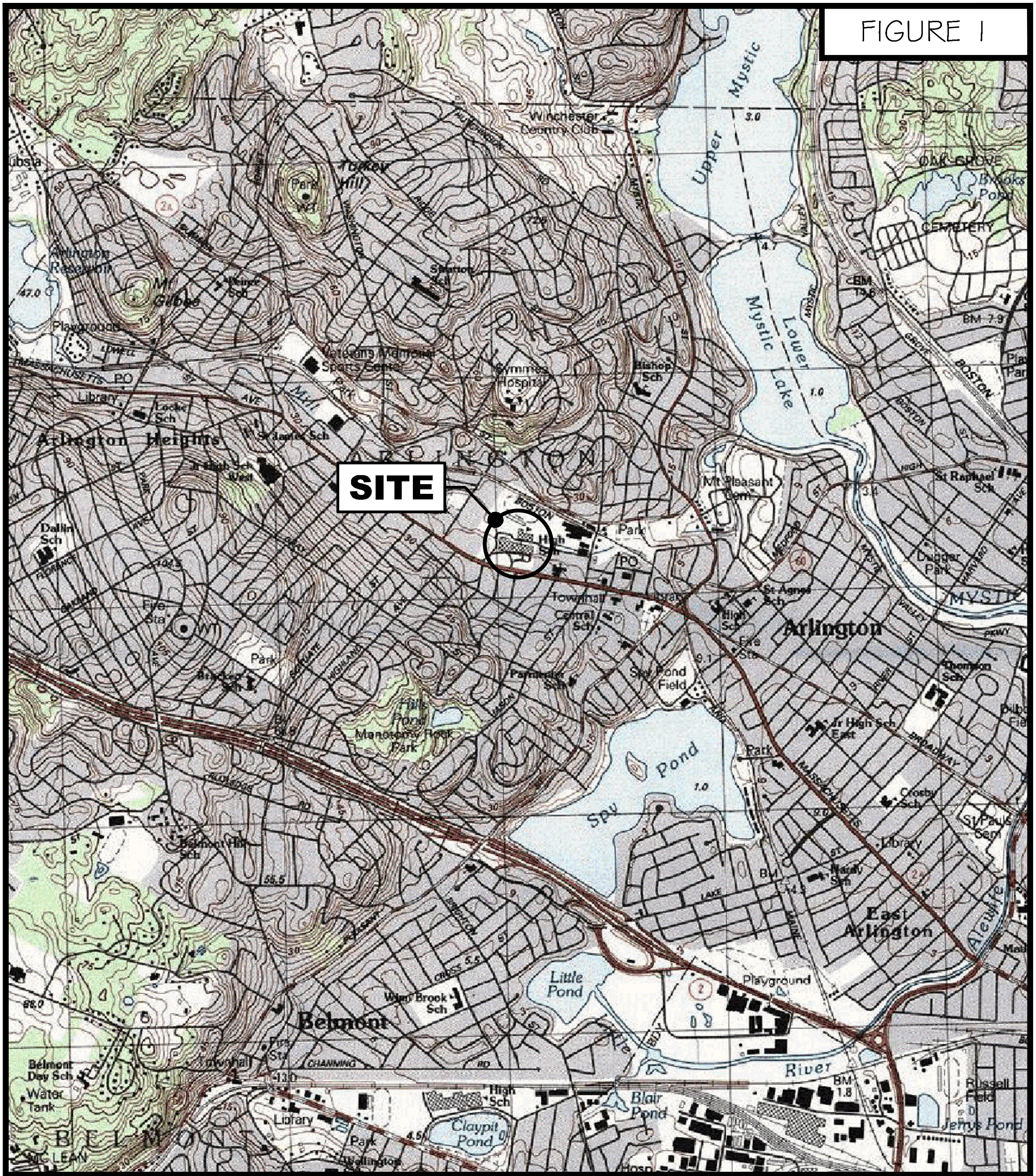
Sincerely,

McPHAIL ASSOCIATES, LLC

William J, Burns L.S.P.

N:\Working Documents\Reports\6531 AHS RGP 020320.docx
WJB/jwp

FIGURE 1



McPHAIL ASSOCIATES, LLC
Geotechnical and Geoenvironmental Engineers
2269 Massachusetts Avenue
Cambridge, MA 02140
617/868-1420
617/868-1423 (Fax)
www.mcphailgeo.com

N

SCALE 1:25,000

PROJECT LOCATION PLAN

ARLINGTON HIGH SCHOOL

ARLINGTON MASSACHUSETTS

McPHAIL ASSOCIATES, LLC
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ARLINGTON HIGH SCHOOL

ARLINGTON MASSACHUSETTS

SITE PLAN + OBSERVATION WELL LOCATION PLAN

FOR

CONSIGLI CONSTRUCTION CO., INC.

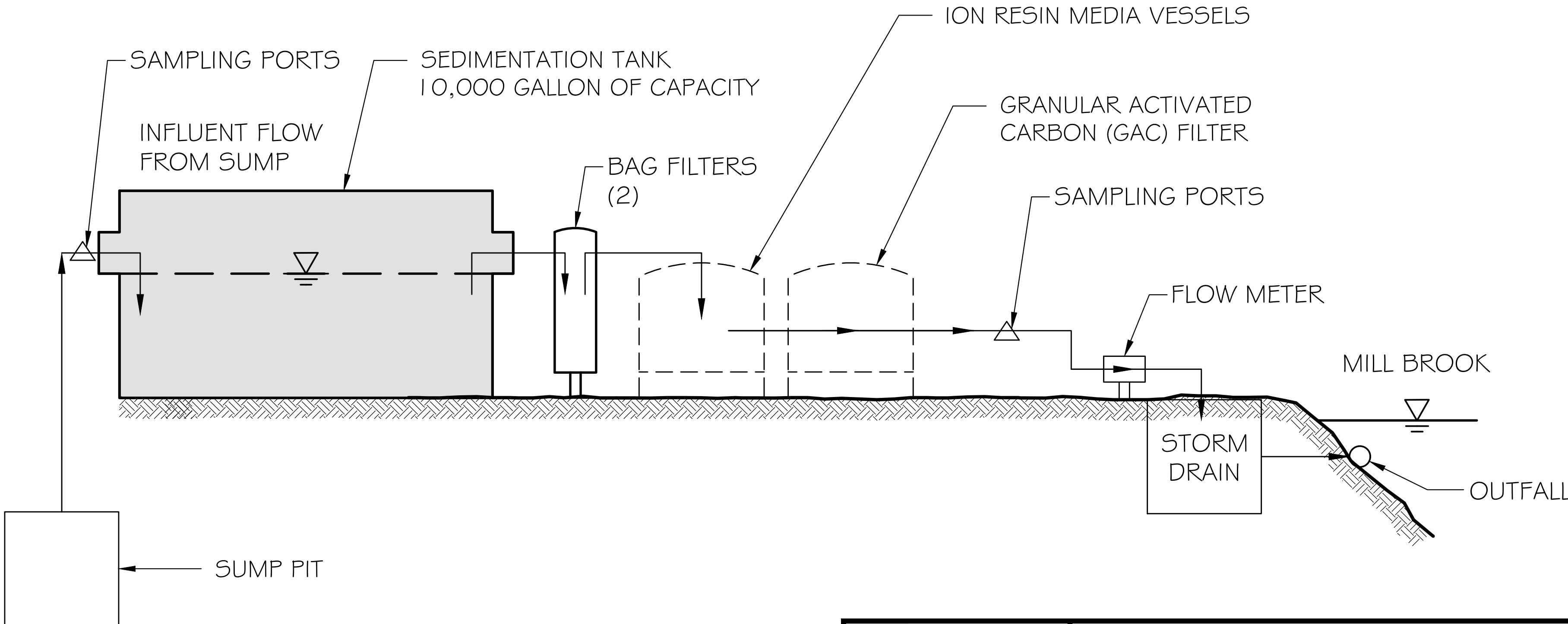
BY

McPHAIL ASSOCIATES, LLC

Date: FEBRUARY 2020	Dwn: I.J.M.	Chkd: W.J.B.	Scale: 1" = 50'
Project No: 6531			FIGURE 2

FILE NAME: N:\Acad\JOBS\6531\Dewatering\6531-E03.dwg

FIGURE 3



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ARLINGTON HIGH SCHOOL
ARLINGTON MASSACHUSETTS

SCHEMATIC OF TREATMENT SYSTEM

FOR

CONSIGLI CONSTRUCTION CO., INC.

BY

McPHAIL ASSOCIATES, LLC
CONSULTING GEOTECHNICAL ENGINEERS

Date: JANUARY 2020	Dwn: I.J.M.	Chkd: W.J.B.	Scale: N.T.S.
Project No: 6531			

TABLE 1
ANALYTICAL RESULTS - GROUNDWATER

Arlington High School
869 Massachusetts Avenue; Arlington, MA
Project No. 6531.9.T7

LOCATION	EPA ALFCCC	GW-2-14	GW-3-14	GP-108 (OW)	MW-04-5	GP-108 (OW)	DEP-6	MW-103
SAMPLING DATE				12/23/2019	12/24/2019	9/24/2019	9/24/2019	9/24/2019
LAB SAMPLE ID				L1961508-01	L1961602-01	L1944134-01	L1944134-02	L1944134-03
SAMPLE TYPE				Groundwater	Groundwater	WATER	WATER	WATER
Anions by Ion Chromatography								
Chloride (ug/l)	230000			**444000**	**748000**	-	-	-
General Chemistry								
Solids, Total Suspended (ug/l)				ND(5000)	ND(5000)	-	-	-
Cyanide, Total (ug/l)	5.2		30	ND(5)	5	-	-	-
Chlorine, Total Residual (ug/l)				ND(20)	ND(20)	-	-	-
pH (S.U.)				6.5	-	-	-	-
Nitrogen, Ammonia (ug/l)				77	856	-	-	-
TPH, SGT-HEM (ug/l)		5000	5000	ND(4000)	ND(4000)	-	-	-
Phenolics, Total (ug/l)				ND(30)	ND(30)	-	-	-
Hardness				111000	94000	-	-	-
Total Metals (ug/l)								
Antimony, Total			8000	ND(4)	ND(4)	-	-	-
Arsenic, Total	150		900	ND(1)	2.77	-	-	-
Cadmium, Total	0.25		4	ND(0.2)	ND(0.2)	-	-	-
Chromium, Total			300	143.1	19.5	-	-	-
Copper, Total				ND(1)	11.57	-	-	-
Chromium, Trivalent	74		600	ND(10)	19	-	-	-
Chromium, Hexavalent	11		300	**160**	ND(10)	-	-	-
Iron, Total	1000			ND(50)	284	-	-	-
Lead, Total	2.5		10	ND(1)	ND(1)	-	-	-
Mercury, Total	0.77		20	ND(0.2)	ND(0.2)	-	-	-
Nickel, Total	52		200	ND(2)	ND(2)	-	-	-
Selenium, Total	5		100	**ND(5)**	**ND(5)**	-	-	-
Silver, Total			7	ND(0.4)	ND(0.4)	-	-	-
Zinc, Total	120		900	ND(10)	ND(10)	-	-	-
Polychlorinated Biphenyls by GC (ug/l)								
Aroclor 1016		5	10	ND(0.25)	ND(0.25)	-	-	-
Aroclor 1221		5	10	ND(0.25)	ND(0.25)	-	-	-
Aroclor 1232		5	10	ND(0.25)	ND(0.25)	-	-	-
Aroclor 1242		5	10	ND(0.25)	ND(0.25)	-	-	-
Aroclor 1248		5	10	ND(0.25)	ND(0.25)	-	-	-
Aroclor 1254		5	10	ND(0.25)	ND(0.25)	-	-	-
Aroclor 1260		5	10	ND(0.2)	ND(0.2)	-	-	-
SUM				ND	ND	-	-	-
Semivolatile Organics by GC/MS (ug/l)								
Bis(2-ethylhexyl)phthalate			50000	ND(2.2)	ND(2.2)	-	-	-
Butyl benzyl phthalate				ND(5)	ND(5)	-	-	-
Di-n-butylphthalate				ND(5)	ND(5)	-	-	-
Di-n-octylphthalate				ND(5)	ND(5)	-	-	-
Diethyl phthalate		50000	9000	ND(5)	ND(5)	-	-	-
Dimethyl phthalate		50000	50000	ND(5)	ND(5)	-	-	-
SUM				ND	ND	-	-	-
Semivolatile Organics by GC/MS-SIM (ug/l)								
Acenaphthene			10000	ND(0.1)	2.9	-	-	-
Fluoranthene			200	ND(0.1)	ND(0.1)	-	-	-
Naphthalene		700	20000	ND(0.1)	0.89	-	-	-
Benzo(a)anthracene			1000	ND(0.1)	ND(0.1)	-	-	-
Benzo(a)pyrene			500	ND(0.1)	ND(0.1)	-	-	-
Benzo(b)fluoranthene			400	ND(0.1)	ND(0.1)	-	-	-
Benzo(k)fluoranthene			100	ND(0.1)	ND(0.1)	-	-	-
Chrysene			70	ND(0.1)	ND(0.1)	-	-	-
Acenaphthylene		10000	40	ND(0.1)	0.55	-	-	-
Anthracene			30	ND(0.1)	ND(0.1)	-	-	-
Benzo(ghi)perylene			20	ND(0.1)	ND(0.1)	-	-	-
Fluorene			40	ND(0.1)	0.6	-	-	-
Phenanthrene			10000	ND(0.1)	ND(0.1)	-	-	-
Dibenzo(a,h)anthracene			40	ND(0.1)	ND(0.1)	-	-	-
Indeno(1,2,3-cd)pyrene			100	ND(0.1)	ND(0.1)	-	-	-
Pyrene			20	ND(0.1)	0.23	-	-	-
Pentachlorophenol	15		200	ND(1)	ND(1)	-	-	-
SUM				ND	5.17	-	-	-
Microextractables by GC (ug/l)								
1,2-Dibromoethane		2	50000	ND(0.01)	ND(0.01)	-	-	-
Volatile Organics by GC/MS (ug/l)								
Methylene chloride		2000	50000	ND(1)	ND(1)	-	-	-
1,1-Dichloroethane		2000	20000	ND(1.5)	ND(1.5)	-	-	-
Carbon tetrachloride		2	5000	ND(1)	ND(1)	-	-	-
1,1,2-Trichloroethane		900	50000	ND(1.5)	ND(1.5)	-	-	-
Tetrachloroethene		50	30000	4.1	ND(1)	-	-	-
1,2-Dichloroethane		5	20000	ND(1.5)	ND(1.5)	-	-	-
1,1,1-Trichloroethane		4000	20000	ND(2)	ND(2)	-	-	-
Benzene		1000	10000	ND(1)	ND(1)	-	-	-
Toluene		50000	40000	ND(1)	ND(1)	-	-	-
Ethylbenzene		20000	5000	ND(1)	10	-	-	-
Vinyl chloride		2	50000	ND(1)	ND(1)	-	-	-
1,1-Dichloroethene		80	30000	ND(1)	ND(1)	-	-	-
cis-1,2-Dichloroethene		20	50000	ND(1)	ND(1)	-	-	-
Trichloroethene		5	5000	ND(1)	ND(1)	-	-	-
1,2-Dichlorobenzene		8000	2000	ND(5)	ND(5)	-	-	-
1,3-Dichlorobenzene		6000	50000	ND(5)	ND(5)	-	-	-
1,4-Dichlorobenzene		60	8000	ND(5)	ND(5)	-	-	-
p/m-Xylene		3000	5000	ND(2)	ND(2)	-	-	-
o-xylene		3000	5000	ND(1)	2.3	-	-	-
Xylenes, Total		3000	5000	ND(1)	2.3	-	-	-
Acetone		50000	50000	ND(10)	ND(10)	-	-	-
Methyl tert butyl ether		50000	50000	ND(10)	ND(10)	-	-	-
Tert-Butyl Alcohol				ND(100)	ND(100)	-	-	-
Tertiary-Amyl Methyl Ether				ND(20)	ND(20)	-	-	-
SUM				4.1	12.3	-	-	-
Volatile Organics by GC/MS-SIM (ug/l)								
1,4-Dioxane		6000	50000	ND(50)	ND(50)	-	-	-

ND-not detected in excess of the laboratory reporting limit in ()
Bold - exceeds EPA water quality criteria - freshwater (chronic)
Tested compounds not shown do not exceed labortory reporting limits

TABLE 1
ANALYTICAL RESULTS - GROUNDWATER

Arlington High School
869 Massachusetts Avenue; Arlington, MA
Project No. 6531.9.T7

LOCATION	EPA ALFCCC	GW-2-14	GW-3-14	GP-108 (OW)	MW-04-5	GP-108 (OW)	DEP-6	MW-103
SAMPLING DATE				12/23/2019	12/24/2019	9/24/2019	9/24/2019	9/24/2019
LAB SAMPLE ID				L1961508-01	L1961602-01	L1944134-01	L1944134-02	L1944134-03
SAMPLE TYPE				Groundwater	Groundwater	WATER	WATER	WATER
MCP Volatile Organics (ug/l)								
Tetrachloroethene		50	30000	-	-	-	**130**	11
Trichloroethene		5	5000	-	-	-	**8.6**	ND(1)
cis-1,2-Dichloroethene		20	50000	-	-	-	**38**	ND(1)
1,2-Dichloroethene, Total				-	-	-	38	ND(1)
SUM				-	-	-	176.6	11
EPH w/MS Targets (ug/l)								
C9-C18 Aliphatics		5000	50000	-	-	ND(100)	-	-
C19-C36 Aliphatics			50000	-	-	ND(100)	-	-
C11-C22 Aromatics, Adjusted		50000	5000	-	-	ND(100)	-	-
Naphthalene		700	20000	-	-	ND(0.4)	-	-
2-Methylnaphthalene		2000	20000	-	-	ND(0.4)	-	-
Acenaphthylene		10000	40	-	-	ND(0.4)	-	-
Acenaphthene			10000	-	-	ND(0.4)	-	-
Fluorene			40	-	-	ND(0.4)	-	-
Phenanthrene			10000	-	-	ND(0.4)	-	-
Anthracene			30	-	-	ND(0.4)	-	-
Fluoranthene			200	-	-	ND(0.4)	-	-
Pyrene			20	-	-	ND(0.4)	-	-
Benzo(a)anthracene			1000	-	-	ND(0.4)	-	-
Chrysene			70	-	-	ND(0.4)	-	-
Benzo(b)fluoranthene			400	-	-	ND(0.4)	-	-
Benzo(k)fluoranthene			100	-	-	ND(0.4)	-	-
Benzo(a)pyrene			500	-	-	ND(0.2)	-	-
Indeno(1,2,3-cd)Pyrene			100	-	-	ND(0.4)	-	-
Dibenzo(a,h)anthracene			40	-	-	ND(0.4)	-	-
Benzo(ghi)perylene			20	-	-	ND(0.4)	-	-
Volatile Petroleum Hydrocarbons (ug/l)								
C9-C10 Aromatics		4000	50000	-	-	ND(100)	-	-
C5-C8 Aliphatics, Adjusted		3000	50000	-	-	ND(100)	-	-
C9-C12 Aliphatics, Adjusted		5000	50000	-	-	ND(100)	-	-
Benzene		1000	10000	-	-	ND(2)	-	-
Toluene		50000	40000	-	-	ND(2)	-	-
Ethylbenzene		20000	5000	-	-	ND(2)	-	-
p/m-Xylene		3000	5000	-	-	ND(2)	-	-
o-Xylene		3000	5000	-	-	ND(2)	-	-
Methyl tert butyl ether		50000	50000	-	-	ND(3)	-	-
Naphthalene		700	20000	-	-	ND(4)	-	-

ND-not detected in excess of the laboratory reporting limit in ()
Bold - exceeds EPA water quality criteria - freshwater (chronic)
Tested compounds not shown do not exceed labortory reporting limits

Table 2 - Analytical Results
Surface Water

Arlington High School
869 Massachusetts Avenue; Arlington, MA
Project No. 6531.9.T7

LOCATION	EPA-ALFCCC	Units	MILL BROOK
SAMPLING DATE			1/8/2020
LAB SAMPLE ID			L2000855-01
SAMPLE TYPE			Seep Water
SAMPLE DEPTH (ft.)			
General Chemistry			
Chromium, Trivalent	74	ug/l	ND(10)
pH (H)		SU	7.5
Nitrogen, Ammonia		ug/l	88
Chromium, Hexavalent	11	ug/l	ND(10)
Total Hardness by SM 2340B			
Hardness		ug/l	79800
Total Metals			
Antimony, Total		ug/l	ND(4)
Arsenic, Total	150	ug/l	ND(1)
Cadmium, Total	0.25	ug/l	ND(0.2)
Chromium, Total		ug/l	ND(1)
Copper, Total		ug/l	1.87
Iron, Total	1000	ug/l	891
Lead, Total	2.5	ug/l	1.71
Mercury, Total	0.77	ug/l	ND(0.2)
Nickel, Total	52	ug/l	ND(2)
Selenium, Total	5	ug/l	**ND(5)**
Silver, Total		ug/l	ND(0.4)
Zinc, Total	120	ug/l	ND(10)

ND-not detected in excess of the laboratory reporting limit in ()
Bold - exceeds EPA water quality criteria - freshwater (chronic)
Tested compounds not shown do not exceed labortory reporting limits

APPENDIX A:

LIMITATIONS

LIMITATIONS

The purpose of this report is to present the results of testing of groundwater samples obtained from monitoring wells located at the Arlington High School campus located at 869 Massachusetts Avenue in Arlington, Massachusetts, in support of an application for approval of construction site dewatering discharge into surface waters of the Commonwealth of Massachusetts under EPA's Massachusetts Remediation General Permit MAG910000.

The observations were made under the conditions stated in this report. The conclusions presented above were based on these observations. If variations in the nature and extent of subsurface conditions between the spaced subsurface explorations become evident in the future, it will be necessary to re-evaluate the conclusions presented herein after performing on-site observations and noting the characteristics of any variations.

The conclusions submitted in this report are based in part upon laboratory test data obtained from analysis of groundwater samples, and are contingent upon their validity. The data have been reviewed, and interpretations have been made in the text. It should also be noted that fluctuations in the types and levels of contaminants and variations in their flow paths may occur due to changes in the seasonal water table, past practices used at the site, and other factors.

Laboratory analyses have been performed for specific constituents during this assessment, as described in the text.

This report and application have been prepared on behalf of and for the exclusive use of HMFH Architects, Inc., the Town of Arlington and Consigli Construction Co., Inc. This report and the findings contained herein shall not, in whole or in part, be disseminated or conveyed to any other party, other than submission to relevant governmental agencies, nor used in whole or in part by any other party without the prior written consent of McPhail Associates, LLC.

APPENDIX B:

NOTICE OF INTENT TRANSMITTAL FORM
ARLINGTON DEWATERING DISCHARGE PERMIT

II. Suggested Format for the Remediation General Permit Notice of Intent (NOI)

A. General site information:

<table>
<tr><td rowspan="2">1. Name of site:
Arlington High School</td><td colspan="3">Site address: 869
Street: Massachusetts Avenue</td></tr>
<tr><td>City: Arlington</td><td>State: MA</td><td>Zip: 02476</td></tr>
<tr><td rowspan="4">2. Site owner
Town of Arlington

Owner is (check one): ☐ Federal ☐ State/Tribal ☐ Private
■ Other; if so, specify: Municipal</td><td colspan="3">Contact Person: Mr. Adam Chapdelaine</td></tr>
<tr><td>Telephone: 781-316-3010</td><td colspan="2">Email: achapdelaine@town.arlington.ma</td></tr>
<tr><td colspan="3">Mailing address: 730
Street: Massachusetts Avenue Annex</td></tr>
<tr><td>City: Arlington</td><td>State: MA</td><td>Zip: 02476</td></tr>
<tr><td rowspan="4">3. Site operator, if different than owner
Consigli Construction Co., Inc.</td><td colspan="3">Contact Person: John LaMarre</td></tr>
<tr><td>Telephone: 617-293-5296</td><td colspan="2">Email: JLaMarre@consigli.com</td></tr>
<tr><td colspan="3">Mailing address:
Street: 72 Sumner Street</td></tr>
<tr><td>City: Milford</td><td>State: MA</td><td>Zip: 01757</td></tr>
<tr><td>4. NPDES permit number assigned by EPA:

NPDES permit is (check all that apply: ☐ RGP ☐ DGP ☐ CGP
☐ MSGP ☐ Individual NPDES permit ☐ Other; if so, specify:</td><td colspan="3">5. Other regulatory program(s) that apply to the site (check all that apply):
■ MA Chapter 21e; list RTN(s):
3-4241, 3-30236, 3-24460
☐ NH Groundwater Management Permit or Groundwater Release Detection Permit:
☐ CERCLA
☐ UIC Program
☐ POTW Pretreatment
☐ CWA Section 404</td></tr>
</table>

B. Receiving water information:

1. Name of receiving water(s): Mill Brook	Waterbody identification of receiving water(s): MA71-07	Classification of receiving water(s): Class B
Receiving water is (check any that apply): ☐ Outstanding Resource Water ☐ Ocean Sanctuary ☐ territorial sea ☐ Wild and Scenic River		
2. Has the operator attached a location map in accordance with the instructions in B, above? (check one): ■ Yes ☐ No Are sensitive receptors present near the site? (check one): ☐ Yes ■ No If yes, specify:		
3. Indicate if the receiving water(s) is listed in the State's Integrated List of Waters (i.e., CWA Section 303(d)). Include which designated uses are impaired, and any pollutants indicated. Also, indicate if a final TMDL is available for any of the indicated pollutants. For more information, contact the appropriate State as noted in Part 4.6 of the RGP. Not an ORW, No TMDL Listed, Escherichia Coli - Impairment		
4. Indicate the seven day-ten-year low flow (7Q10) of the receiving water determined in accordance with the instructions in Appendix V for sites located in Massachusetts and Appendix VI for sites located in New Hampshire.	0.114 MGD	
5. Indicate the requested dilution factor for the calculation of water quality-based effluent limitations (WQBELs) determined in accordance with the instructions in Appendix V for sites in Massachusetts and Appendix VI for sites in New Hampshire.	1.79	
6. Has the operator received confirmation from the appropriate State for the 7Q10and dilution factor indicated? (check one): ■ Yes ☐ No If yes, indicate date confirmation received: 01/30/2020		
7. Has the operator attached a summary of receiving water sampling results as required in Part 4.2 of the RGP in accordance with the instruction in Appendix VIII? (check one): ■ Yes ☐ No		

C. Source water information:

1. Source water(s) is (check any that apply):			
■ Contaminated groundwater Has the operator attached a summary of influent sampling results as required in Part 4.2 of the RGP in accordance with the instruction in Appendix VIII? (check one): ■ Yes ☐ No	☐ Contaminated surface water Has the operator attached a summary of influent sampling results as required in Part 4.2 of the RGP in accordance with the instruction in Appendix VIII? (check one): ☐ Yes ☐ No	☐ The receiving water ☐ A surface water other than the receiving water; if so, indicate waterbody:	☐ Potable water; if so, indicate municipality or origin: ☐ Other; if so, specify:

2. Source water contaminants: Chromium VI, Chromium III, CVOCs, TPH	
a. For source waters that are contaminated groundwater or contaminated surface water, indicate are any contaminants present that are not included in the RGP? (check one): ☐ Yes ■ No If yes, indicate the contaminant(s) and the maximum concentration present in accordance with the instructions in Appendix VIII.	b. For a source water that is a surface water other than the receiving water, potable water or other, indicate any contaminants present at the maximum concentration in accordance with the instructions in Appendix VIII? (check one): ☐ Yes ☐ No
3. Has the source water been previously chlorinated or otherwise contains residual chlorine? (check one): ☐ Yes ■ No	

D. Discharge information

1.The discharge(s) is a(n) (check any that apply): ☐ Existing discharge ■ New discharge ☐ New source	
Outfall(s): Outfall No. 1. Outfall No. 2 Outfall No. 3	Outfall location(s): (Latitude, Longitude) 42.4197, -71.1628 42.4186, -71.1609 42.4180, -71.1601
Discharges enter the receiving water(s) via (check any that apply): ☐ Direct discharge to the receiving water ■ Indirect discharge, if so, specify: On-site storm drain system which discharges in Mill Brook culvert ☐ A private storm sewer system ■ A municipal storm sewer system If the discharge enters the receiving water via a private or municipal storm sewer system: Has notification been provided to the owner of this system? (check one): ■ Yes ☐ No Has the operator has received permission from the owner to use such system for discharges? (check one): ■ Yes ☐ No, if so, explain, with an estimated timeframe for obtaining permission: Has the operator attached a summary of any additional requirements the owner of this system has specified? (check one): ☐ Yes ■ No	
Provide the expected start and end dates of discharge(s) (month/year): 04/01/2020 - 05/01/2025 Indicate if the discharge is expected to occur over a duration of: ☐ less than 12 months ■ 12 months or more ☐ is an emergency discharge	
Has the operator attached a site plan in accordance with the instructions in D, above? (check one): ■ Yes ☐ No	

<table>
<tr><th>2. Activity Category: (check all that apply)</th><th colspan="2">3. Contamination Type Category: (check all that apply)</th></tr>
<tr><td rowspan="4">☐ I – Petroleum-Related Site Remediation
☐ II – Non-Petroleum-Related Site Remediation
■ III – Contaminated Site Dewatering
☐ IV – Dewatering of Pipelines and Tanks
☐ V – Aquifer Pump Testing
☐ VI – Well Development/Rehabilitation
☐ VII – Collection Structure Dewatering/Remediation
☐ VIII – Dredge-Related Dewatering</td><td colspan="2">a. If Activity Category I or II: (check all that apply)

☐ A. Inorganics
☐ B. Non-Halogenated Volatile Organic Compounds
☐ C. Halogenated Volatile Organic Compounds
☐ D. Non-Halogenated Semi-Volatile Organic Compounds
☐ E. Halogenated Semi-Volatile Organic Compounds
☐ F. Fuels Parameters</td></tr>
<tr><td colspan="2">b. If Activity Category III, IV, V, VI, VII or VIII: (check either G or H)</td></tr>
<tr><td>■ G. Sites with Known Contamination</td><td>☐ H. Sites with Unknown Contamination</td></tr>
<tr><td>c. If Category III-G, IV-G, V-G, VI-G, VII-G or VIII-G: (check all that apply)

■ A. Inorganics
☐ B. Non-Halogenated Volatile Organic Compounds
■ C. Halogenated Volatile Organic Compounds
■ D. Non-Halogenated Semi-Volatile Organic Compounds
☐ E. Halogenated Semi-Volatile Organic Compounds
■ F. Fuels Parameters</td><td>d. If Category III-H, IV-H, V-H, VI-H, VII-H or VIII-H Contamination Type Categories A through F apply</td></tr>
</table>

4. Influent and Effluent Characteristics

Parameter	Known or believed absent	Known or believed present	# of samples	Test method (#)	Detection limit (μg/l)	Influent		Effluent Limitations	
						Daily maximum (μg/l)	Daily average (μg/l)	TBEL	WQBEL
A. Inorganics									
Ammonia		✔	2	121,4500	75	856	466.5	Report mg/L	---
Chloride		✔	2	443000	500	748000	596000	Report μg/l	---
Total Residual Chlorine	✔		2	121,4500	20	<DL	<DL	0.2 mg/L	
Total Suspended Solids		✔	2	121,2450I	5000	<DL	<DL	30 mg/L	
Antimony	✔		2	1,6020A	4	<DL	<DL	206 μg/L	
Arsenic	✔		2	1,6020A	1	2.77	1.885	104 μg/L	
Cadmium	✔		2	1,6020A	0.2	<DL	<DL	10.2 μg/L	
Chromium III		✔	2	1,6020A	10	19	14.5	323 μg/L	
Chromium VI		✔	2	1,6020A	1	160	85	323 μg/L	
Copper	✔		2	1,6020A	1	11.57	6.29	242 μg/L	20
Iron	✔		2	19200.7	50	284	167	5,000 μg/L	
Lead	✔		2	1,6020A	1	<DL	<DL	160 μg/L	
Mercury	✔		2	3,245.1	0.2	<DL	<DL	0.739 μg/L	
Nickel	✔		2	1,6020A	2	<DL	<DL	1,450 μg/L	
Selenium	✔		2	1,6020A	5	<DL	<DL	235.8 μg/L	
Silver	✔		2	1,6020A	0.4	<DL	<DL	35.1 μg/L	
Zinc	✔		2	1,6020A	10	<DL	<DL	420 μg/L	
Cyanide	✔		2	121,4500	5	5	5	178 mg/L	
B. Non-Halogenated VOCs									
Total BTEX	✔		2	128,624.1	1	14.3	9.15	100 μg/L	---
Benzene	✔		2	128,624.1	1	<DL	<DL	5.0 μg/L	---
1,4 Dioxane	✔		2	128,624.1	50	<DL	<DL	200 μg/L	---
Acetone	✔		2	128,624.1	10	<DL	<DL	7.97 mg/L	---
Phenol	✔		2	128,624.1	2.0	<DL	<DL	1,080 μg/L	

Parameter	Known or believed absent	Known or believed present	# of samples	Test method (#)	Detection limit (µg/l)	Influent		Effluent Limitations	
						Daily maximum (µg/l)	Daily average (µg/l)	TBEL	WQBEL
C. Halogenated VOCs									
Carbon Tetrachloride	✔		2	128,624.1	1	<DL	<DL	4.4 µg/L	
1,2 Dichlorobenzene	✔		2	128,624.1	5	<DL	<DL	600 µg/L	---
1,3 Dichlorobenzene	✔		2	128,624.1	5	<DL	<DL	320 µg/L	---
1,4 Dichlorobenzene	✔		2	128,624.1	5	<DL	<DL	5.0 µg/L	---
Total dichlorobenzene	✔		2	128,624.1	5	<DL	<DL	763 µg/L in NH	---
1,1 Dichloroethane	✔		2	128,624.1	1.5	<DL	<DL	70 µg/L	---
1,2 Dichloroethane	✔		2	128,624.1	1.5	<DL	<DL	5.0 µg/L	---
1,1 Dichloroethylene	✔		2	128,624.1	1	<DL	<DL	3.2 µg/L	---
Ethylene Dibromide	✔		2	128,624.1	1	<DL	<DL	0.05 µg/L	---
Methylene Chloride	✔		2	128,624.1	1	<DL	<DL	4.6 µg/L	---
1,1,1 Trichloroethane	✔		2	128,624.1	2	<DL	<DL	200 µg/L	---
1,1,2 Trichloroethane	✔		2	128,624.1	1.5	<DL	<DL	5.0 µg/L	---
Trichloroethylene		✔	2	128,624.1	1	<DL	<DL	5.0 µg/L	---
Tetrachloroethylene		✔	2	128,624.1	1	4.1	2.55	5.0 µg/L	
cis-1,2 Dichloroethylene		✔	2	128,624.1	1	<DL	<DL	70 µg/L	---
Vinyl Chloride		✔	2	128,624.1	1	<DL	<DL	2.0 µg/L	---
D. Non-Halogenated SVOCs									
Total Phthalates	✔		2	129,625.1	0.1	<DL	<DL	190 µg/L	
Diethylhexyl phthalate	✔		2	129,625.1	0.1	<DL	<DL	101 µg/L	
Total Group I PAHs	✔		2	129,625.1	0.1	5.17	3.89	1.0 µg/L	---
Benzo(a)anthracene	✔		2	129,625.1	0.1	<DL	<DL		
Benzo(a)pyrene	✔		2	129,625.1	0.1	<DL	<DL		
Benzo(b)fluoranthene	✔		2	129,625.1	0.1	<DL	<DL		
Benzo(k)fluoranthene	✔		2	129,625.1	0.1	<DL	<DL	As Total PAHs	
Chrysene	✔		2	129,625.1	0.1	<DL	<DL		
Dibenzo(a,h)anthracene	✔		2	129,625.1	0.1	<DL	<DL		
Indeno(1,2,3-cd)pyrene	✔		2	129,625.1	0.1	<DL	<DL		

Parameter	Known or believed absent	Known or believed present	# of samples	Test method (#)	Detection limit (µg/l)	Influent		Effluent Limitations	
						Daily maximum (µg/l)	Daily average (µg/l)	TBEL	WQBEL
Total Group II PAHs			2	18270D-S	0.1	5.17	3.89	100 µg/L	---
Naphthalene		✔	2	129,625.1	2.5	0.89	0.5	20 µg/L	---
E. Halogenated SVOCs									
Total PCBs	✔		2	127.608.3	0.25	<DL	<DL	0.000064 µg/L	---
Pentachlorophenol	✔		2	18270D-S	0.8	<DL	<DL	1.0 µg/L	---
F. Fuels Parameters									
Total Petroleum Hydrocarbons		✔	2	74.1664A	400	<DL	<DL	5.0 mg/L	---
Ethanol	✔							Report mg/L	---
Methyl-tert-Butyl Ether	✔		2	1,8260C	1.0	<DL	<DL	70 µg/L	
tert-Butyl Alcohol	✔		2	1,8260C	10	<DL	<DL	120 µg/L in MA 40 µg/L in NH	---
tert-Amyl Methyl Ether	✔		2	1,8260C	20	<DL	<DL	90 µg/L in MA 140 µg/L in NH	---
Other (i.e., pH, temperature, hardness, salinity, LC_{50}, additional pollutants present); if so, specify:									
pH - Influent			1	121,4500		6.5	6.5		
temperature -Influent			1	Horiba					
hardness - Influent			2	EPA 300		111000	102500		
pH - receiving water			1	121,4500		7.5	7.5		
Hardness - Receiving Water			1	EPA 300		79800	79800		
Temp - Receiving Water									
		✔							

E. Treatment system information

1. Indicate the type(s) of treatment that will be applied to effluent prior to discharge: (check all that apply)

☐ Adsorption/Absorption ☐ Advanced Oxidation Processes ☐ Air Stripping ■ Granulated Activated Carbon ("GAC")/Liquid Phase Carbon Adsorption
■ Ion Exchange ☐ Precipitation/Coagulation/Flocculation ☐ Separation/Filtration ☐ Other; if so, specify:

2. Provide a written description of all treatment system(s) or processes that will be applied to the effluent prior to discharge.
Bag filters, sedimentation tank, GAC filter and ion resin exchange filter in series

Identify each major treatment component (check any that apply):
■ Fractionation tanks☐ Equalization tank ☐ Oil/water separator ☐ Mechanical filter ■ Media filter
☐ Chemical feed tank ☐ Air stripping unit ■ Bag filter ☐ Other; if so, specify:

Indicate if either of the following will occur (check any that apply):
☐ Chlorination ☐ De-chlorination

3. Provide the **design flow capacity** in gallons per minute (gpm) of the most limiting component. Indicate the most limiting component: Fractionation tank Is use of a flow meter feasible? (check one): ■ Yes ☐ No, if so, provide justification:	100
Provide the proposed maximum effluent flow in gpm.	100
Provide the average effluent flow in gpm.	50
If Activity Category IV applies, indicate the estimated total volume of water that will be discharged:	N/A

4. Has the operator attached a schematic of flow in accordance with the instructions in E, above? (check one): ■ Yes ☐ No

F. Chemical and additive information

1. Indicate the type(s) of chemical or additive that will be applied to effluent prior to discharge or that may otherwise be present in the discharge(s): (check all that apply)

☐ Algaecides/biocides ☐ Antifoams ☐ Coagulants ☐ Corrosion/scale inhibitors ☐ Disinfectants ☐ Flocculants ☐ Neutralizing agents ☐ Oxidants ☐ Oxygen ☐ scavengers ☐ pH conditioners ☐ Bioremedial agents, including microbes ☐ Chlorine or chemicals containing chlorine ☐ Other; if so, specify:

2. Provide the following information for each chemical/additive, using attachments, if necessary:

a. Product name, chemical formula, and manufacturer of the chemical/additive;
b. Purpose or use of the chemical/additive or remedial agent;
c. Material Safety Data Sheet (MSDS) and Chemical Abstracts Service (CAS) Registry number for each chemical/additive;
d. The frequency (hourly, daily, etc.), duration (hours, days), quantity (maximum and average), and method of application for the chemical/additive;
e. Any material compatibility risks for storage and/or use including the control measures used to minimize such risks; and
f. If available, the vendor's reported aquatic toxicity (NOAEL and/or LC50 in percent for aquatic organism(s)).

3. Has the operator attached an explanation which demonstrates that the addition of such chemicals/additives may be authorized under this general permit in accordance with the instructions in F, above? (check one): ☐ Yes ■ No; if no, has the operator attached data that demonstrates each of the 126 priority pollutants in CWA Section 307(a) and 40 CFR Part 423.15(j)(1) are non-detect in discharges with the addition of the proposed chemical/additive? (check one): ■ Yes ☐ No

G. Endangered Species Act eligibility determination

1. Indicate under which criterion the discharge(s) is eligible for coverage under this general permit:

■ **FWS Criterion A**: No endangered or threatened species or critical habitat are in proximity to the discharges or related activities or come in contact with the "action area".

☐ **FWS Criterion B**: Formal or informal consultation with the FWS under section 7 of the ESA resulted in either a no jeopardy opinion (formal consultation) or a written concurrence by FWS on a finding that the discharges and related activities are "not likely to adversely affect" listed species or critical habitat (informal consultation). Has the operator completed consultation with FWS? (check one): ☐ Yes ☐ No; if no, is consultation underway? (check one): ☐ Yes ☐ No

☐ **FWS Criterion C**: Using the best scientific and commercial data available, the effect of the discharges and related activities on listed species and critical habitat have been evaluated. Based on those evaluations, a determination is made by EPA, or by the operator and affirmed by EPA, that the discharges and related activities will have "no effect" on any federally threatened or endangered listed species or designated critical habitat under the jurisdiction of the FWS. This determination was made by: (check one) ☐ the operator ☐ EPA ☐ Other; if so, specify:

☐ **NMFS Criterion**: A determination made by EPA is affirmed by the operator that the discharges and related activities will have "no effect" or are "not likely to adversely affect" any federally threatened or endangered listed species or critical habitat under the jurisdiction of NMFS and will not result in any take of listed species. Has the operator previously completed consultation with NMFS? (check one): ☐ Yes ☐ No

2. Has the operator attached supporting documentation of ESA eligibility in accordance with the instructions in Appendix I, and G, above? (check one): ☐ Yes ☐ No

Does the supporting documentation include any written concurrence or finding provided by the Services? (check one): ☐ Yes ☐ No; if yes, attach.

H. National Historic Preservation Act eligibility determination

1. Indicate under which criterion the discharge(s) is eligible for coverage under this general permit:

■ **Criterion A**: No historic properties are present. The discharges and discharge-related activities (e.g., BMPs) do not have the potential to cause effects on historic properties.

☐ **Criterion B**: Historic properties are present. Discharges and discharge related activities do not have the potential to cause effects on historic properties.

☐ **Criterion C**: Historic properties are present. The discharges and discharge-related activities have the potential to have an effect or will have an adverse effect on historic properties.

2. Has the operator attached supporting documentation of NHPA eligibility in accordance with the instructions in H, above? (check one): ☐ Yes ■ No

Does the supporting documentation include any written agreement with the State Historic Preservation Officer (SHPO), Tribal Historic Preservation Officer (TPHO), or other tribal representative that outlines measures the operator will carry out to mitigate or prevent any adverse effects on historic properties? (check one): ☐ Yes ■ No

I. Supplemental information

Describe any supplemental information being provided with the NOI. Include attachments if required or otherwise necessary.

Has the operator attached data, including any laboratory case narrative and chain of custody used to support the application? (check one): ■ Yes ☐ No

Has the operator attached the certification requirement for the Best Management Practices Plan (BMPP)? (check one): ■ Yes ☐ No

J. Certification requirement

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I have no personal knowledge that the information submitted is other than true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.	
BMPP certification statement: A BMPP Statement has been implemented in accordance with good engineering practices following Part 2.5 of the RGP and shall be implemented upon initiation of discharge.	
Notification provided to the appropriate State, including a copy of this NOI, if required.	Check one: Yes ■ No ☐
Notification provided to the municipality in which the discharge is located, including a copy of this NOI, if requested.	Check one: Yes ■ No ☐
Notification provided to the owner of a private or municipal storm sewer system, if such system is used for site discharges, including a copy of this NOI, if requested.	Check one: Yes ■ No ☐ NA ☐
Permission obtained from the owner of a private or municipal storm sewer system, if such system is used for site discharges. If yes, attach additional conditions. If no, attach explanation and timeframe for obtaining permission.	Check one: Yes ☐ No ■ NA ■
Notification provided to the owner/operator of the area associated with activities covered by an additional discharge permit(s). Additional discharge permit is (check one): ☐ RGP ☐ DGP ☐ CGP ☐ MSGP ☐ Individual NPDES permit ☐ Other; if so, specify:	Check one: Yes ☐ No ■ NA ■
Signature: [signature]	Date: 2/24/20
Print Name and Title: John LaMarre, Senior Project Manager	

APPENDIX C:

DEP PRIORITY RESOURCES MAP

USGS STREAMFLOW STATISTICS REPORT

DILUTION FACTOR AND WQBEL CALCULATIONS

ADDITIONAL NOI SUPPORT INFORMATION

MassDEP - Bureau of Waste Site Cleanup

Phase 1 Site Assessment Map: 500 feet & 0.5 Mile Radii

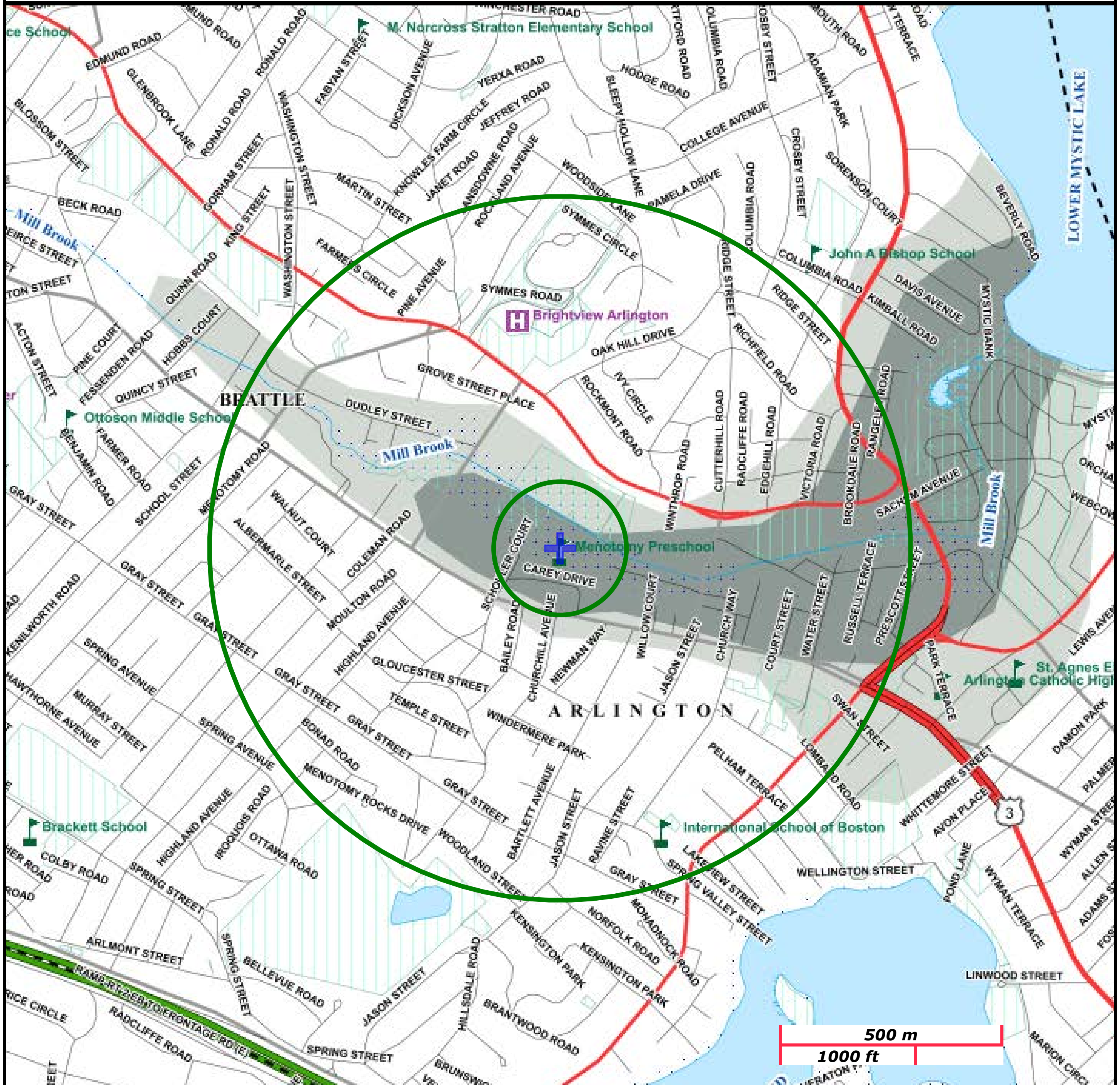
Site Information:

869 MASSACHUSETTS AVE ARLINGTON, MA

NAD83 UTM Meters:
4698487mN , 322146mE (Zone: 19)
February 3, 2020

The information shown is the best available at the date of printing. However, it may be incomplete. The responsible party and LSP are ultimately responsible for ascertaining the true conditions surrounding the site. Metadata for data layers shown on this map can be found at: https://www.mass.gov/orgs/massgis-bureau-of-geographic-information.

MassDEP
Commonwealth of Massachusetts
Department of Environmental Protection



Roads: Limited Access, Divided, Other Hwy, Major Road, Minor Road, Track, Trail

Boundaries: Town, County, DEP Region; Train; Powerline; Pipeline; Aqueduct

Basins: Major, PWS; Streams: Perennial, Intermittent, Man Made Shore, Dam

Aquifers: Medium Yield, High Yield, EPA Sole Source

Non Potential Drinking Water Source Area: Medium, High (Yield)

PWS Protection Areas: Zone II, IWPA, Zone A

Hydrography: Open Water, PWS Reservoir, Tidal Flat

Wetlands: Freshwater, Saltwater, Cranberry Bog

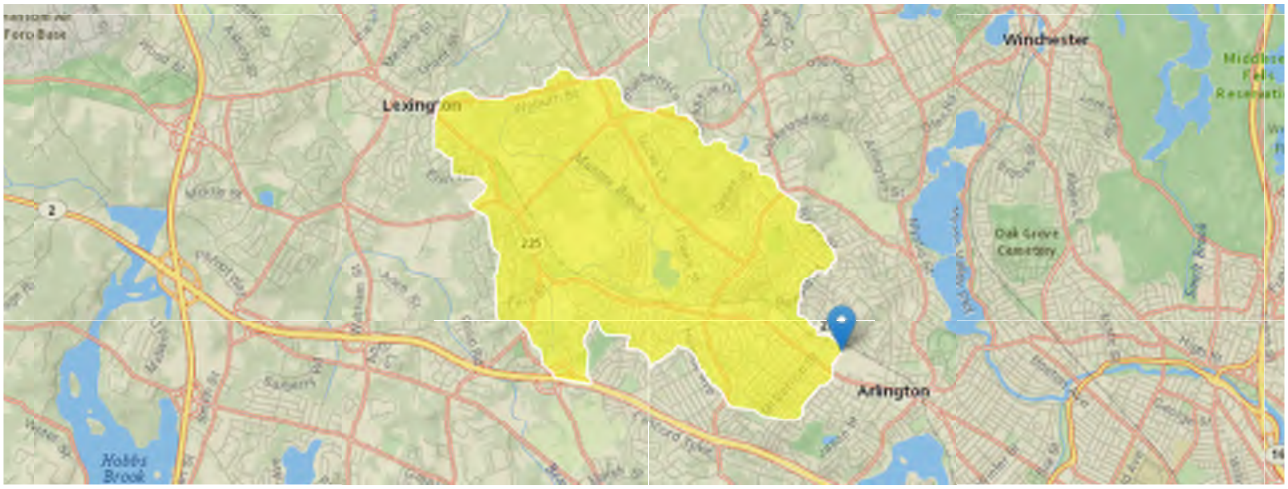
FEMA 100yr Floodplain; Protected Open Space; ACEC

Est. Rare Wetland Wildlife Hab; Vernal Pool: Cert., Potential

Solid Waste Landfill; PWS: Com.GW,SW, Emerg.,Non-Com.

StreamStats Report

Region ID:	MA
Workspace ID:	MA20191230143442307000
Clicked Point (Latitude, Longitude):	42.42008, -71.16407
Time:	2019-12-30 09:34:57 -0500



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	4.5	square miles
BSLDEM250	Mean basin slope computed from 1:250K DEM	3.065	percent
DRFTPERSTR	Area of stratified drift per unit of stream length	0.17	square mile per mile
MAREGION	Region of Massachusetts 0 for Eastern 1 for Western	0	dimensionless

Low-Flow Statistics Parameters[Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	4.5	square miles	1.61	149
BSLDEM250	Mean Basin Slope from 250K DEM	3.065	percent	0.32	24.6
DRFTPERSTR	Stratified Drift per Stream Length	0.17	square mile per mile	0	1.29
MAREGION	Massachusetts Region	0	dimensionless	0	1

Low-Flow Statistics Flow Report[Statewide Low Flow WRIR00 4135]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	Plu	SE	SEp
7 Day 2 Year Low Flow	0.417	ft^3/s	0.15	1.12	49.5	49.5
7 Day 10 Year Low Flow	0.176	ft^3/s	0.0495	0.585	70.8	70.8

Low-Flow Statistics Citations

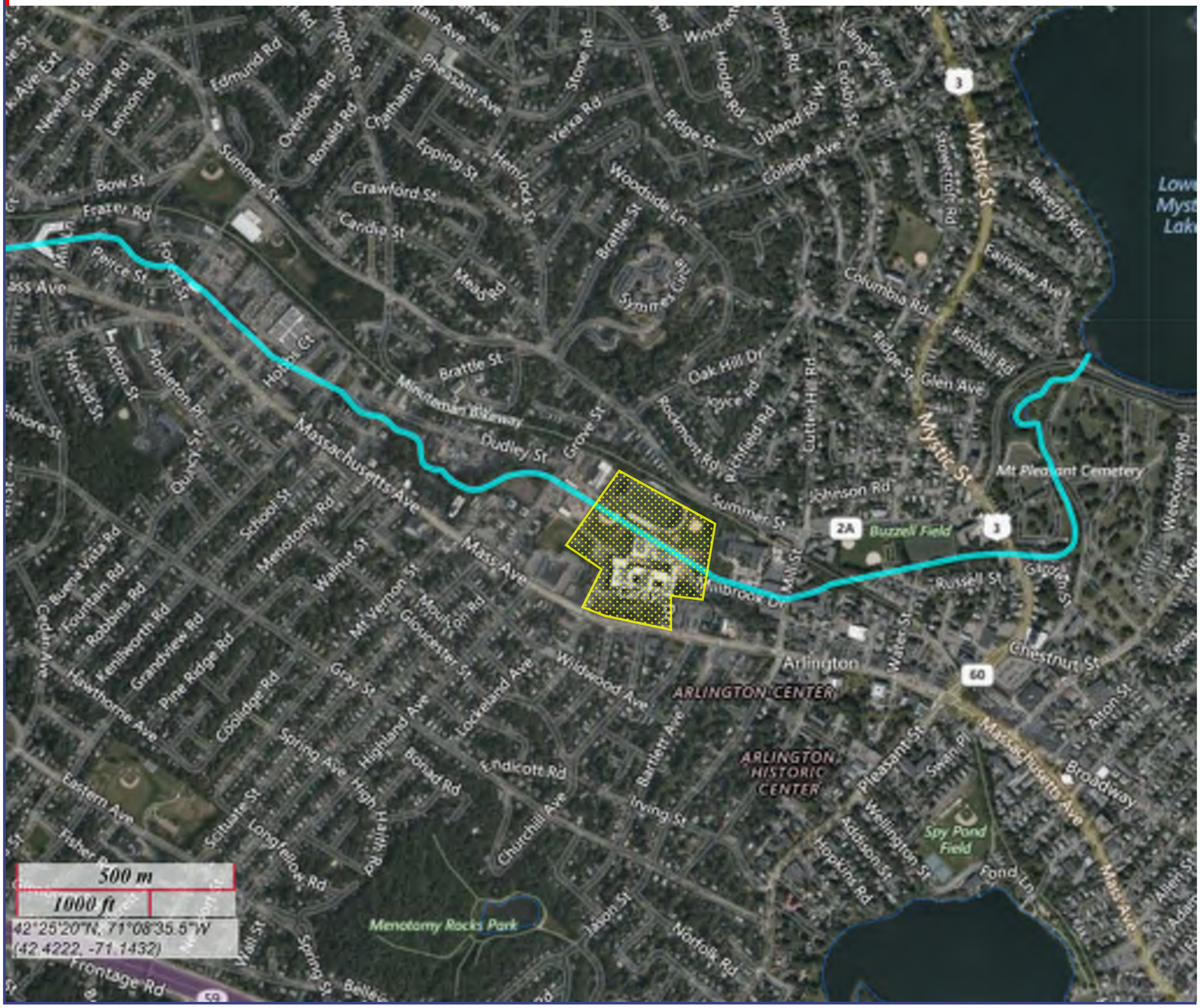
Ries, K.G., III,2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (http://pubs.usgs.gov/wri/wri004135/)

MassDEP Online Map Viewer

2014 Integrated List of Waters Map

Helpful Links:

- The Clean Water Act
- MassDEP Total Maximum Daily Loads



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Dilution Factor 1.8

	TBEL applies if bolded		WQBEL applies if bolded		Compliance Level applies if shown	
A. Inorganics						
Ammonia	**Report**	mg/L	---			
Chloride	**Report**	µg/L	---			
Total Residual Chlorine	0.2	mg/L	**20**	µg/L	50	µg/L
Total Suspended Solids	**30**	mg/L	---			
Antimony	**206**	µg/L	1147	µg/L		
Arsenic	**104**	µg/L	18	µg/L		
Cadmium	**10.2**	µg/L	1.4844	µg/L		
Chromium III	**323**	µg/L	531.9	µg/L		
Chromium VI	323	µg/L	**20.5**	µg/L		
Copper	**242**	µg/L	59.3	µg/L		
Iron	**5000**	µg/L	1086	µg/L		
Lead	**160**	µg/L	37.62	µg/L		
Mercury	**0.739**	µg/L	1.62	µg/L		
Nickel	**1450**	µg/L	335.3	µg/L		
Selenium	**235.8**	µg/L	9.0	µg/L		
Silver	**35.1**	µg/L	91.1	µg/L		
Zinc	**420**	µg/L	771.8	µg/L		
Cyanide	**178**	mg/L	9.3	µg/L	---	µg/L
B. Non-Halogenated VOCs						
Total BTEX	**100**	µg/L	---			
Benzene	**5.0**	µg/L	---			
1,4 Dioxane	**200**	µg/L	---			
Acetone	**7970**	µg/L	---			
Phenol	**1,080**	µg/L	538	µg/L		
C. Halogenated VOCs						
Carbon Tetrachloride	**4.4**	µg/L	2.9	µg/L		
1,2 Dichlorobenzene	**600**	µg/L	---			
1,3 Dichlorobenzene	**320**	µg/L	---			
1,4 Dichlorobenzene	**5.0**	µg/L	---			
Total dichlorobenzene	**---**	µg/L	---			
1,1 Dichloroethane	**70**	µg/L	---			
1,2 Dichloroethane	**5.0**	µg/L	---			
1,1 Dichloroethylene	**3.2**	µg/L	---			
Ethylene Dibromide	**0.05**	µg/L	---			
Methylene Chloride	**4.6**	µg/L	---			
1,1,1 Trichloroethane	**200**	µg/L	---			
1,1,2 Trichloroethane	**5.0**	µg/L	---			
Trichloroethylene	**5.0**	µg/L	---			
Tetrachloroethylene	**5.0**	µg/L	5.9	µg/L		
cis-1,2 Dichloroethylene	**70**	µg/L	---			
Vinyl Chloride	**2.0**	µg/L	---			
D. Non-Halogenated SVOCs						
Total Phthalates	190	µg/L	---	µg/L		
Diethylhexyl phthalate	**101**	µg/L	3.9	µg/L		

Total Group I Polycyclic Aromatic Hydrocarbons	**1.0**	µg/L	---			
Benzo(a)anthracene	**1.0**	µg/L	0.0068	µg/L	---	µg/L
Benzo(a)pyrene	**1.0**	µg/L	0.0068	µg/L	---	µg/L
Benzo(b)fluoranthene	**1.0**	µg/L	0.0068	µg/L	---	µg/L
Benzo(k)fluoranthene	**1.0**	µg/L	0.0068	µg/L	---	µg/L
Chrysene	**1.0**	µg/L	0.0068	µg/L	---	µg/L
Dibenzo(a,h)anthracene	**1.0**	µg/L	0.0068	µg/L	---	µg/L
Indeno(1,2,3-cd)pyrene	**1.0**	µg/L	0.0068	µg/L	---	µg/L
Total Group II Polycyclic Aromatic Hydrocarbons	**100**	µg/L	---			
Naphthalene	**20**	µg/L	---			
E. Halogenated SVOCs						
Total Polychlorinated Biphenyls	**0.000064**	µg/L	---		0.5	µg/L
Pentachlorophenol	**1.0**	µg/L	---			
F. Fuels Parameters						
Total Petroleum Hydrocarbons	**5.0**	mg/L	---			
Ethanol	**Report**	mg/L	---			
Methyl-tert-Butyl Ether	**70**	µg/L	36	µg/L		
tert-Butyl Alcohol	**120**	µg/L	---			
tert-Amyl Methyl Ether	**90**	µg/L	---			

Massachusetts Category 5 Waters
"Waters requiring a TMDL"

NAME	SEGMENT ID	DESCRIPTION	SIZE	UNITS	IMPAIRMENT CAUSE	EPA TMDL NO.
Malden River	MA71-05	Headwaters south of Exchange Street, Malden to confluence with Mystic River, Everett/Medford.	2.3	MILES	(Debris/Floatables/Trash*)	
					Chlordane	
					DDT	
					Dissolved oxygen saturation	
					Escherichia coli	
					Fecal Coliform	
					Foam/Flocs/Scum/Oil Slicks	
					Oxygen, Dissolved	
					PCB in Fish Tissue	
					pH, High	
					Phosphorus (Total)	
					Secchi disk transparency	
					Sediment Bioassays -- Chronic Toxicity Freshwater	
					Taste and Odor	
					Total Suspended Solids (TSS)	
Mill Brook	MA71-07	Headwaters south of Massachusetts Avenue, Lexington to inlet of Lower Mystic Lake, Arlington (portions culverted underground).	3.9	MILES	(Physical substrate habitat alterations*)	
					Escherichia coli	
Mill Creek	MA71-08	From Route 1, Chelsea/Revere to confluence with Chelsea River, Chelsea/Revere.	0.02	SQUARE MILES	Fecal Coliform	
					Other	
					PCB in Fish Tissue	
Mystic River	MA71-02	Outlet Lower Mystic Lake, Arlington/Medford to Amelia Earhart Dam, Somerville/Everett.	4.9	MILES	(Fish-Passage Barrier*)	
					Arsenic	
					Chlordane	
					Chlorophyll-a	
					DDT	
					Dissolved oxygen saturation	
					Escherichia coli	
					PCB in Fish Tissue	
					Phosphorus (Total)	
					Secchi disk transparency	
					Sediment Bioassays -- Chronic Toxicity Freshwater	

* TMDL not required (Non-pollutant)

McPHAIL ASSOCIATES, LLC

APPENDIX F:

BEST MANAGEMENT PRACTICE PLAN

A Notice of Intent for a Remediation General Permit (RGP) under the National Pollutant Discharge Elimination System (NPDES) has been submitted to the US Environmental Protection Agency (EPA) in anticipation of temporary construction dewatering that will occur during redevelopment of the Arlington High School located at 869 Massachusetts Avenue in Arlington, Massachusetts. This Best Management Practices Plan (BMPP) has been prepared as an Appendix to the RGP application and will be posted at the site during the time period that temporary construction dewatering is occurring at the site.

Water Treatment and Management

During installation of the proposed geothermal wells and excavation activities related to the construction of the proposed Arlington High School complex, dewatering effluent is anticipated to be pumped from localized sumps and trenches within the excavation directly into a settling tank. Existing plans that have been prepared for the Arlington High School campus indicate that the on-site storm drainage system connects to the Mill Brook culvert which traverses beneath the northern portion of the site. Dewatering effluent treatment will consist of a settling tank and bag filters to remove suspended soil particulates as well as a granular activated carbon filter and ion resign exchange filter to remove CVOCs and metals prior to off-site discharge.

Discharge Monitoring and Compliance

Regular sampling and testing will be conducted of both the influent to the system and the treated effluent as required by the RGP. During the first week of discharge, the operator must sample the untreated influent and treated effluent two times: one (1) sample of untreated influent and one (1) sample of treated effluent be collected on the first day of discharge, and one (1) sample of untreated influent and one (1) sample of treated effluent must be collected on one additional non-consecutive day within the first week of discharge. Samples must be analyzed in accordance with 40 CFR §136 unless otherwise specified by the RGP, with a maximum 5-day turnaround time and results must be reviewed no more than 48 hours from receipt of the results of each sampling event. After the first week, samples may be analyzed with up to a ten (10)-day turnaround time and results must be reviewed no more than 72 hours from receipt of the results. If the treatment system is

operating as designed and achieving the effluent limitations outlined in the RGP, on-going sampling shall be conducted weekly for three (3) additional weeks beginning no earlier than 24 hours following initial sampling, and monthly as described below. Any adjustments/reductions in monitoring frequency must be approved by EPA in writing.

In accordance with Part 4.1 of the RGP, the operator must perform routine monthly monitoring for both influent and effluent beginning no more than 30 days following the completion of the sampling requirements for new discharges or discharges that have been interrupted. The routine monthly monitoring is to be conducted through the end of the scheduled discharge. The routine monthly monitoring must continue for five (5) consecutive months prior to submission of any request for modification of monitoring frequency.

Dewatering activity for the Site is classified as Category III-G: Sites with Known Contamination. Monitoring shall include analysis of influent and effluent samples dictated by the EPA.

Monitoring will include checking the condition of the treatment system, assessing the need for treatment system adjustments based on monitoring data, observing and recording daily flow rates and discharge quantities, and verifying the flow path of the discharged effluent.

The total monthly flow will be monitored by checking and documenting the flow through the flow meter to be installed on the system. Flow will be maintained below the “system design flow” by regularly monitoring flow and adjusting the amount of construction dewatering as needed. Monthly monitoring reports will be compiled and maintained at the site. Any exceedances will be documented and conveyed to the EPA within 24 hours of received concentrations.

System Maintenance

A number of methods will be used to minimize the potential for excursions during the term of this permit discharge. Scheduled regular maintenance and periodic cleaning of the treatment system will be conducted to verify proper operation and shall be conducted in accordance with Section 1.11 of the project earthwork specifications. Regular maintenance will include checking the condition of the treatment system equipment such as the settling tanks, bag filters, filtration media, hoses, pumps, and flow meters. Equipment will be monitored daily for potential issues and unscheduled maintenance requirements.

Employees who have direct or indirect responsibility for ensuring compliance with the RGP will be trained by the Contractor.

Miscellaneous Items

It is anticipated that the erosion control measures and the nature of the site will minimize potential runoff to or from the site. The project specifications also include requirements for

erosion control. Site security for the treatment system will be addressed within the overall site security plan.

No adverse effects on designated uses of surrounding surface water bodies is anticipated. The closest body of water is the Lower Mystic Lake located approximately 0.65-miles to the northeast of the project site. Dewatering effluent will be pumped into a settling tank. Water within the settling tank will pumped through bag filters, a GAC filter and ion resin exchange filter prior to discharge into the storm drains.

Management of Treatment System Materials

Dewatering effluent will be pumped directly into the treatment system from geothermal well installation and the excavation with use of hoses and localized sumps to minimize handling. The Contractor will establish staging areas for equipment or materials storage that may be possible sources of pollution away from any dewatering activities, to the extent practicable.

Sediment from the tank used in the treatment system will be characterized and removed from the site to an appropriate receiving facility, in accordance with applicable laws and regulations. Bag filters as well as spent carbon and ion resin filtration media will be replaced/disposed of as necessary.

Introduction

The goal of this document is to serve as a Notice of Intent Supplemental Narrative supporting backup to responses provided by John Amato of JJA Sports, LLC relating to questions from Commission Members during the May 21 hearing on the proposed infill synthetic turf sports fields. At meeting close a general list of items requiring further clarification was provided, which included:

- Provide information related to Per and Polyfluoroalkyl Substances (PFAS) testing for solids referenced during the question and answer period in relative to current New York State Standards. New York is the only State with a current soils testing requirement which be followed under this design submittal for solids within the turf matrix. This requirement outlined herein and will be included within the Synthetic Turf Playing Surface technical specifications for project.
- Provide a recommended testing program for the existing Brook follow to determine current background levels of Per and Polyfluoroalkyl Substances (PFAS) within the water body.
- Provide additional information related to ASTM Testing Methods for lead and heavy metals. This requirement is outlined herein and will be included within the Synthetic Turf Playing Surface technical specifications for project.
- Provide a summary of synthetic turf fields and how they are climate resilience.
- Provide a summary of synthetic turf fields and how they provided extended use over that of natural turf grass field.
- Provide summary of required maintenance hours and a recommend standard maintenance practices for the synthetic turf sports field. Typical Recommended Minimum Maintenance Program will be included herein.

The format for each response includes a general recap of the provided answer and additional support information. Where specific reference was made to inclusions within the technical specification specific excerpts will be included herein.

Per and Polyfluoroalkyl Substances (PFAS) Synthetic Turf Product Testing

An October 8, 2019 article in The Intercept published entitled, "Toxic PFAs Chemicals Found in Artificial Turf" regarding a synthetic field site in Massachusetts, has become an issue of concern in the U.S. synthetic turf industry. According to the EPA (https://www.epa.gov/pfas/basic-information-pfas);

> "PFAs are a group of chemicals that include PFOA, PFOS GenX, and many other chemicals. PFAS have been manufactured and used in a variety of industries around the globe, including in the United States since the 1940s. PFOA and PFOS have been the most extensively produced and studied of these chemicals. Both chemicals are very persistent in the environment and in the human body – meaning they don't break down and they can accumulate over time. There is evidence that exposure to PFAS can lead to adverse human health effects."

Article Claims

According to the article, which was picked up by the Boston Globe, two samples of backing material and eight samples of turf blade fibers, sampled and provided by Public Employees for Environmental Responsibility (PEER), "a service organization for local, state, federal and tribal law enforcement officers, scientists, land managers, and other professionals dedicated to upholding environmental laws and values," were tested by Ecology Center, "a nonprofit organization located in Berkeley, California that focuses on improving the health and the environmental impacts of urban residents," from a field site in Franklin, Massachusetts. The article indicated that in the two backing test results "PFAs chemicals were detected." It further indicated, "the blades of artificial grass were analyzed, scientist measured significant levels of fluorine, which is an indication of the presence of the chemicals."

Research Behind the Claims

As of the date of the article, methods for the testing of solid materials for the presence of PFAS were not approved by the Federal EPA or any of the State Regulatory Agencies. The EPA approved method at the time of the article was a test method for water quality samples EPA Test Method 537.1, currently being, validated for air and soil as well (EPA Drinking Water Laboratory Method 537 Q &A, https://www.epa.gov/pfas/epa-drinking-water-laboratory-method-537-qa). According to the above referenced EPA source testing for air and soil have not been validated across multiple laboratories. At this point the test would not be acceptable by the EPA for providing reliably certifiable results.

In addition to the above noted use of EPA Method 537, two concerns have been noted by David Teter of Farallon Consulting, an expert on environmentally compatibility of synthetic turf. According to his review of the laboratory test report from the Ecology Center, the sampling for PFAs is a complicated process and requires a sampling and analysis plan (SAP) which was not included in the report. Without a proper SAP cross-contamination and other sampling shortcomings may impact the results making them invalid. The second item is the method of chemical identification used by the Ecology Center is particle-induced gamma ray emission (PIGE) spectroscopy which is not capable of detecting PFAs. Detections by this method only indicate the presents of fluorine containing compounds. Using this method and claiming to have detected PFAs is quite a reach.

Having fluorine in a compound, when detected by PIGE, does not indicate that PFAs are present. The assumption is invalid without the use of a proper detection method. According to EPA Method 537 Liquid Chromatography (LC)/LC Tandom Mass Spectrometer should be used for detection of PFAs. The eight fiber blade samples tested detected using PIGE may be a fluorine-based non-PFAs process aid, and therefore the results should also be considered as being invalid for PFAs.

Another item that should be considered is that carbon tetrafluoride, a preflourocarbon (PFC), the only naturally occurring PFC, is a naturally occurring fluorine based non-toxic compound that is emitted from granite. The same granite used as a stone base for most synthetic turf fields in New England. The direct contact of the turf backing material and the crushed granite stone base, and possibly cross-contaminating

everything above the stone, may be the source of the detected fluorine. Not having proper sampling protocols would have increased the potential of cross-contamination by carbon tetrafluoride.

Recent Regulatory Progress

More recently, December 19, 2019, the EPA has issued EPA 533 which allows the testing of additional PFAS for water quality purposes. For several years laboratories have been utilizing various modifications of EPA 537 to test solids for the presence of PFAS. All laboratories have their own modification of the method; have varying minimum reporting, recording limits, and report using various criteria. Early this year, the New York Department of Environment and Conservation provided a standard for testing solids using EPA 533 which was recently approved by the EPA, following Isotope Dilution techniques by Liquid Chromatography Tandem Mass Spectrometry as 537.1 M. Reporting limits shall not exceed 0.5 µg/kg (NYDEC part 375), and the reporting criteria shall be less than or equal to 1.0 µg/k kg (NYDEC part 375). This test method is the basis for a new testing requirement that will be included in my standard synthetic turf playing surface specification.

The following is an excerpt from my current standard specification:

"1.08 SUBMITTALS

A. Environmental Health and Safety: Fiber and Infill materials shall be tested for compliance with the following:

3. Provide Independent Compliance Testing by an accredited and or approved laboratory for compliance with State Regulations for Per and Polyfluoroalkyl Substances (PFAS) in solids using EPA 537.1 Modified with Isotope Dilution techniques by Liquid Chromatography Tandem Mass Spectrometry (LC/MS/MS) by a laboratory accredited and or approved for these tests. Two of the compounds identified in the list below can only be tested for using EPA 533 which was recently approved by the EPA, which should follow the same Isotope Dilution techniques by Liquid Chromatography Tandem Mass Spectrometry as 537.1 M. Reporting limits shall not exceed 0.5 µg/kg (NYDEC part 375), and the reporting criteria shall be less than or equal to 1.0 µg/k kg (NYDEC part 375). Turf fibers and backing materials shall be sampled using State Approved Protocol for soil sampling. The testing shall include the following PFAS.

Test Method	Compound	Abbreviation	CASRN	PubChem NIH Safety Class
EPA 537.1	Hexafluoropropylene oxide dimer acid	HFPO-DA	13252-13-6b	Corrosive-Irritant
EPA 537.1	N-ethyl perfluorooctanesulfonamidoacetic acid	NEtFOSAA	2991-50-6	ENV Contaminant
EPA 537.1	N-methyl perfluorooctanesulfonamidoacetic acid	NMeFOSAA	2355-31-9	ENV Contaminant
EPA 537.1	Perfluorobutanesulfonic acid	PFBS	375-73-5	Corrosive-Irritant
EPA 537.1	Perfluorodecanoic acid	PFDA	335-76-2	Corrosive-Acute Toxicity-Irritant
EPA 537.1	Perfluorododecanoic acid	PFDoA	307-55-1	Corrosive-Irritant
EPA 537.1	Perfluoroheptanoic acid	PFHpA	375-85-9	Corrosive-Irritant

EPA 537.1	Perfluorohexanesulfonic acid	PFHxS	355-46-4	Corrosive-Irritant
EPA 537.1	Perfluorohexanoic acid	PFHxA	307-24-4	Corrosive
EPA 537.1	Perfluorononanoic acid	PFNA	375-95-1	Corrosive-Irritant
EPA 537.1	Perfluorooctanesulfonic acid	PFOS	1763-23-1	Corrosive-Health Hazard-Irritant-ENV Hazard
EPA 537.1	Perfluorooctanoic acid	PFOA	335-67-1	Corrosive-Health Hazard-Irritant
EPA 537.1	Perfluorotetradecanoic acid	PFTA	376-06-7	Corrosive
EPA 537.1	Perfluorotridecanoic acid	PFTrDA	72629-94-8	Unavailable at PubChem NIH
EPA 537.1	Perfluoroundecanoic acid	PFUnA	2058-94-8	Irritant
EPA 537.1	11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	763051-92-9c	Unavailable at PubChem NIH
EPA 537.1	9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid	9Cl-PF3ONS	756426-58-1d	Corrosive-Irritant
EPA 537.1	4,8-dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4e	Corrosive-Irritant
EPA 533	Perfluorobutanoic acid	PFBA	375-22-4	Corrosive-Irritant
EPA 533	Perfluoropentanoic acid	PFPeA	2706-90-3	Corrosive
Note: Includes compounds regulated in northeast states tested under both EPA 537.1 and EPA 533				

PFAS Background Level Testing

A request was made by the Commission to develop a testing approach in order to determine and quantify the presence of PFAS in Mill Brook. It is important to consider the fact that Mill Brook is not a drinking water source and testing for PFAS levels in non-drinking water is not regulatory requirement. It does however provide a baseline for any potential contamination that may exist prior to construction. The criteria thresholds would not apply.

The recommended approach would be sampling at two specific times at both the DPW and residential ends of the box culvert. Two samples should be taken at each end approximately 3 weeks apart prior to installation of the turf fields. Sampling and testing should be run through McPhail Associates. These same tests could be done one year after completion of work.

Consideration should be given to the fact that the Arlington Fire Station is upstream on Mill Brook from the site and any potential leaks from past Aqueous Film Firefighting Foams (AFFF) which contain PFAS may show up in this potential testing. This should not be done without approval from the Town Government.

ASTM Testing Methods for Lead and Heavy Metals

A discussion regarding health and safety testing included during the question and answer period covered testing for potential levels of both lead and heavy metals under the synthetic turf playing surface technical section.

<u>Material Exposures</u>

Health-related material exposures have been brought to the attention of the synthetic turf industry through studies and news reports over the past 14 years. These concerns have been related to several

items. First was potential latex in the crumb SBR infill and associated latex allergy concerns referenced in a 2003 study. The second issue pertained to lead in the synthetic turf fibers, based on findings in New Jersey. The next was the presence of potential extractable heavy metals in infill associated with claims of cancer in Washington State soccer players in 2015. As new concerns have been presented over the past 14 years, the ASTM through F08.65 Subcommittee on Artificial Turf and synthetic turf industry have endeavored to perform additional research, and develop new methods to test their products and address these concerns.

Latex Allergies

A Norwegian Pollution Control Authority/Norwegian Institute for Air Research report labeled NILU OR 03/2006 entitled “Measurement of Air Pollution in Indoor Artificial Turf Halls,” cited concerns that persons with latex allergies may have health problems when exposed to crumb SRB recycled car tires. Their concern was based on a statement that an average European car tire consists of 42% rubber. Further and more important, the rubber used consists of 58.3% synthetic rubber and 41.7% natural rubber. Latex allergies tend to be related to exposure to latex allergen proteins.

According to the U. S Tire Manufacture’s Association, natural rubber represents 19% of the material in passenger car tires, and 34% in commercial truck tires. The synthetic rubber portion of materials in passenger car tires is approximately 24%. This is consistent with the above noted percentages in European car tires. The natural rubber component in tires is dry natural rubber. It provides tear and fatigue crack resistance, which are important charateristics for tires.

Natural rubber is created from the latex of the rubber tree Hevea brasiliensis. It is processed into two different rubbers, natural rubber latex and dry natural rubber. Natural rubber latex, or soft dipped latex rubber, represents approximately 10% of the latex manufactured. This type of rubber is used in the manufacturing of items such as medical gloves and not used in tire manufacturing. According to the American Latex Allergy Association, “Newer rubber medical supplies, particularly very soft "dipped" products, contain the greatest proportion of low molecular weight soluble proteins thought to be responsible for the allergic response.” Dipped latex products are responsible for most allergic reactions to natural rubber latex (D.D. Fett Ahmed et al / Immunol Allergy Clin N Am 23 2003)

The remaining portion of the latex, approximately 90%, is processed into dry natural rubber, used in tire manufacturing, rubber thread products, rubber seals and diaphragms, or other dry rubber products. Dry natural rubber is processed by acid coagulation into dry sheets or crumbled particles (D.D. Fett Ahmed et al / Immunol Allergy Clin N Am 23 2003). In order for tires to be heat resistant and maintain their elastic characteristics they are vulcanized at high temperatures which are be expected to destroy proteins in the natural rubber (Latex Allergens in Tire Dust and Airborne Particles, Ann G. Miguel,. 1993).

In confirmation of this, according to the American Latex Allergy Association and based on a case in Maryland, testing found no concern for latex exposure from tire crumb. The result was that they were not able to detect any extractable latex allergen, in testing, of the recycled auto-tire matting material. Studying this further, auto and truck tire companies do not use natural rubber latex in their manufacturing. The study did note that the Maryland case was limited in coverage.

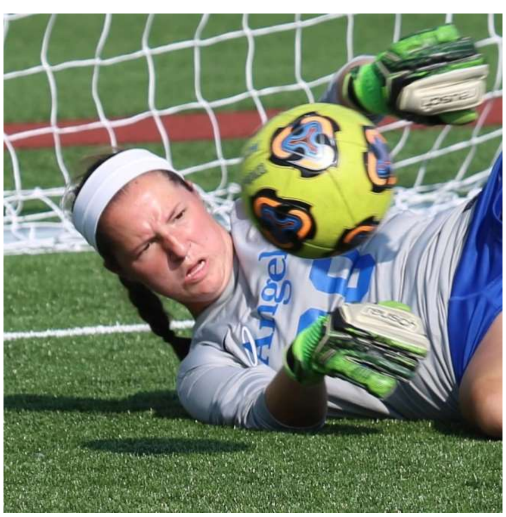
Lead in Fibers

In 2008, concerns related to lead found in the synthetic turf fibers of several fields in New Jersey prompted the synthetic turf industry to address this issue. In response, the Synthetic Turf Council and ASTM F08.65 developed a standard for testing fibers to comply with the Consumer Product Safety Improvement Act of 2008, which addresses lead content in children's toys.

This test was published in 2009 and revised in 2012. The ASTM 2765 "Standard Specification for Total Lead Content in Synthetic Turf Fibers" required lead in synthetic turf fibers to be less than 300 parts per million (ppm) for products manufactured between 2009 and 2011 and below 100 ppm by 2012. Since then, lead content has generally been less than 40 ppm in all tests submitted to JJA Sports as part of construction material review process.

Soccer Players and Cancer in the News

NBC News released a story back in October 2015 that was widely circulated. The University of Washington Women's Associate Head Soccer Coach, Amy Griffin, became concerned about the amount of cancer among soccer players in Washington State, and compiled a list of soccer players with cancer. Coach Griffin was especially concerned about the number of goalkeepers she identified with cancer, and wondered whether exposure to crumb rubber infill in artificial turf may have been causing it. She contacted NBC News.



The material in question was crumb SBR or recycled automobile tire shredded down to a size of less than 1/8 of an inch. SBR used in tire manufacturing includes a family of synthetic rubbers derived from styrene and butadiene (the version developed by Goodyear is called Neolite).

Goodyear discovered the process of strengthening rubber, known as *vulcanization* or *curing,* by accident in 1839. This process is still used today in manufacturing automobile tires. This process modifies rubber to hold its shape and to return to its original shape after a load is removed. Vulcanizing crosslinks the molecules and makes them tougher and more durable. This

process creates a long chain molecule that encapsulates the components.

Environmental advocates asked the EPA and the CPSC to take a closer look. While both the CPSC and the EPA performed studies over five years ago, both agencies recently backtracked on their assurances that the material was safe, calling their studies "limited."

While the EPA told NBC News in a statement that "more testing needs to be done," the agency also said that it considered artificial turf to be a "state and local decision" and would not be commissioning further research.

Based on a demand from then-President Obama, the EPA, CPSC, and CDC were directed to undertake a study to resolve concerns that the use of synthetic turf fields may represent a health risk.

The Massachusetts Department of Public Health issued a statement that established risk factors for Hodgkin Lymphoma include exposure to the Epstein-Barr virus (EBV), a previous diagnosis of mononucleosis (mono is caused by EBV), family history, and certain hereditary conditions (such as ataxia telangiectasia) associated with a weakened immune system.

Further, the Massachusetts Department of Public Health stated that occupational exposures as risk factors have been studied extensively and that none have emerged as risk factors. Likewise, there is very little evidence linking the risk of Hodgkin Lymphoma to an environmental exposure other than EBV.

Federal Research

Because of the need for additional information, the U.S. EPA, the Centers for Disease Control and Prevention, the Agency for Toxic Substances and Disease Registry, and the CPSC in 2015 launched a multi-agency action plan to study key environmental human health questions based on President Obama’s demand.

In the meantime, the ASTM F08.65 Subcommittee on Artificial Turf developed a standard test method to evaluate infill to the same criteria as children's toys. The F3188 Standard Specification for Extractable Hazardous Metals in Synthetic Turf Infill Materials was approved June 1, 2016 and published June 2016. This standard method created a test that was modeled after the CPSC toy standard for use by the synthetic turf industry.

During December 2016, the EPA issued a 169-page status report consisting of a study of available research to date. No new testing was included. The report excluded a reference to the new F3188 Standard Specification for Extractable Hazardous Metals in Synthetic Turf Infill Materials, which was developed in conjunction with the CPSC.

As of March 2018, in a presentation to the STC, the EPA indicated that they believe a report would be available for peer review towards the end of this year. However, there was no mention of the new F3188 Standard Specification for Extractable Hazardous Metals in Synthetic Turf Infill Materials that was developed in conjunction with the CPSC.

The EPA has still not completed their study.

Washington State Department of Public Health

In 2017, the Washington State Department of Health Study published its "Investigation of Reported Cancer among Soccer Players in Washington State". Cathy Wasserman, Office of the State Health Officer, Non-Infectious Conditions Epidemiology, concluded:

> "Findings do not suggest that soccer players, select and premier soccer players, or goalkeepers in Washington are at increased risk for cancer compared to the general population. In addition, the currently available research on the 5 health effects of artificial turf does not suggest that artificial turf presents a significant public health risk. Assurances of the safety of artificial turf, however, are limited by lack of adequate information on potential toxicity and exposure."

Additional Studies and Conclusions

The Dutch National Institute for Public Health and the Environment found that, "The health risk of playing sports on synthetic turf fields with an infill of rubber granulate is virtually negligible."

A UC Davis Study ("Incidence of Malignant Lymphoma in Adolescents and Young Adults in the 58 Counties of California with Varying Synthetic Turf Field Density") recently found, "These overall epidemiologic findings are consistent with studies that have measured levels of carcinogens released from crumb rubber from synthetic turf fields and interpreted their data to indicate negligible cancer risk to children or older persons."

European Risk Assessment Study on Synthetic Turf Rubber Infill

In March of 2020 the Part 3: Exposure and Risk Characterization of a European wide study concluded Cancer risks for exposure to PAHs were below 1: 1 million and that risks for non-carcinogenic substances were below 1.

Current Test Methods for Lead and Extractable Heavy Metals Testing

As noted during the hearing ASTM F08.65 has been at the forefront the development of testing methods is response to concerns brought up by concerned citizens and special interest groups. The testing methods resulted are an integral part of the JJA Sports standard synthetic turf playing surface technical specifications and will be part of the Arlington specification.

The two standards discussed during the hearing related to lead and extractable heavy metals are included as an excerpt below:

"1.08 SUBMITTALS

A. Environmental Health and Safety: Fiber and Infill materials shall be tested for compliance with the following:

1. Provide Independent Compliance Testing for compliance with ASTM F2765-14 Standard Specification for Total Lead Content in Synthetic Turf Fibers

2. Provide Independent Compliance Testing for compliance with ASTM F3188-17 Standard Specification for Extractable Hazardous Metals in Synthetic Turf Infill Materials."

Climate Resilience and Environmental Impact

The 'all-weather' extent of the synthetic turf field depends on the local climate, as well as, on which products are used and how they are assembled. In addition, recent extreme cold winter weather has taught the industry that some combinations of materials do not survive extreme winter as well as others. Over the past two winter seasons, several synthetic turf fields underwent surface damage due to ice formation.

Owners should proceed with caution when selecting turf, infill option, and resilient pad to incorporate into their investment. Soil conditions and potential geotextile fabrics must also be properly vetted. Vendors will say that their product has been tested to perform properly, but they do not always do the appropriate testing to determine if the materials will be appropriate for the climate or the conditions created by a given set of design factors.

During the hottest periods of a summer day, here in the northeast, fields can become too hot to play on. There have been many recommendations made by various companies to address this condition. Some recommend watering the field. This appears to be a reasonable approach however applying the same amount of water that is recommended for natural turf grass irrigation can cool a field 20 degrees Fahrenheit for just 30 to 40 minutes. This approach is a waste of precious water. There are other methods such as using organic infill, or different color infill, there is even a spray that allows fields to undergo limited cooling by evaporative cooling. These have limited effectiveness and result in 5 to 20 degrees in temperature reduction.

The most practical method of addressing a too hot synthetic field surface is to avoid the surface during the heat of the day. Cool the athlete using misting stations. Provide plenty of water so athletes can hydrate. Providing sideline shade using pop-up tents is also very helpful. The shade works by blocking the access of solar radiation to the surface. Regardless of your approach there will be periods during the day where it is best to stay off the field. Owners should schedule the use of the field during summer months to avoid being on the fields. Summer recreation programs should schedule indoor programs during these high heat periods. Starting earlier in the morning, schedule a planned break from lunch to 2 or later and finish as the sun is lower in the sky.

This same high heat that increases the surface temperature of synthetic turf fields, increases surface evaporation, causing drying out of the growing medium in natural turf grass fields. This condition impacts the health of the turf grass by increasing competition for nutrients and water. Stressed turf grass can easily be overtaken by aggressive weeds and pests. Turf grass roots become weakened and the growing medium becomes compacted further energizing this downhill process. Use of this field at anytime during the summer causes high stress on the plant life. This in-turn reduces playable hours in the fall.

The increased water demand and increase mitigative maintenance adds costs to maintaining natural turf grass fields and results in lost use time.

It is common knowledge that infill synthetic turf fields become hot during summer months. Less well-known, is that the solar radiation on the synthetic fiber blade produces this heat. The fact that the temperature of the turf drops quickly if the sun becomes blocked by clouds demonstrates this in the field. It should be noted that the temperature ¼" under the infill within the turf is the same as ambient air. Under these high heat conditions a properly specified synthetic turf playing surface can remain highly durable through many summer seasons beyond their standard warranty period of eight years.

Cold Condition Durability

The image to the left represents the opposite end of the climate performance spectrum. This field normally has optimal drainage; however, the picture shows that it has frozen solid following a period of rain then extreme cold. The rain can be seen pooling in the center of the image. Just like a natural turf grass field, an infill synthetic turf field can freeze under certain conditions and prevent proper drainage and impact safe playability.

The majority of days, were the surface is clear of snow and ice, a synthetic turf field will provide a highly durable and safe playing surface. In fact, you can expect a slight surface warming during the winter providing added warmth to athletes. In the southern New England states a two to four inch snowfall can be removed by clearing the snow at multiple areas and allowing the sun to melt and clear the remaining snow.

Heat Island Effect

A heat island effect is an area that is significantly warmer than its surrounding areas due to human activities. More specifically, it is an increase in temperature due to the surface retaining heat at a level that exceeds that of adjacent surfaces. In 2008, the New York City Department of Health generated a report entitled "New York City Department of Health and Mental Hygiene." They noted that synthetic turf fields have the potential to create heat island effects in the city.

Surface temperatures of infill synthetic turf systems at Brigham Young University have been reported to be as high as 93°C (200°F) on a day when air temperatures were 37°C (99°F) (Brakeman, 2004). In direct sunlight during the hottest part of the day in the summer months, the upper layer of the synthetic turf, which is exposed to the sun's rays, will become significantly hotter than grass. Surface temperatures can reach temperatures as high as 40°F to 100°F above that of the air temperature depending upon location.
Heat Exposure

The same solar-generated heat that can create problems following an improper choice of infill can also render a surface temporarily unsafe for play. Solar radiation reflecting from the surface of the fibers can raise temperatures significantly above that of the ambient air. These temperatures can render a field too

hot to play on during midday periods in the summer. Surface temperature can be over 70˚F **above** surrounding ambient temperatures.

Recorded Field Surface and Air Temperatures						
Field ID	30-Jun-04			3-Aug-04		
A	Surface	Air	Delta	Surface	Air	Delta
B	125.4	78.3	47.1	139.1	86.9	52.2
C	126.3	77.9	48.4	128.8	84	44.8
D	126.1	79	47.1	137.1	87.4	49.7
E	136.6	78.1	58.5	148.6	82.9	65.7
F	142	78.6	63.4	159.4	85.1	74.3
G	133.5	77.2	56.3	160.7	87.1	73.6
H	127.8	78.4	49.4	147.6	84.7	62.9
I	132.1	78.1	54	145.6	84.9	60.7
J	130.1	77.9	52.2	144.7	84.4	60.3
K	118.6	78.4	40.2	129.9	86	43.9
Maximum Observed Delta			63.4			74.3

Source: Penn State Center for Sports Surface Research

Field Demand and Use Capacity

A wide range of total use hours for the given field types has been published. Depending on whether the information is obtained from a natural turf industry source or a synthetic turf industry source, the total hours of use could differ significantly. A rule of thumb for both is that the maintenance hours increase with the hours of use.

The following is a list of key considerations that one may take into account when selecting an athletic surface.

- A synthetic turf field surface can be almost all-weather. Note that anything that is wet and retains moisture will freeze in below-freezing temperatures. There are times when a synthetic turf field is much too hot to be used. Infill synthetic turf fields recover from extreme weather conditions far more rapidly than natural turf grass fields.
- A natural turf field has limitations in very wet and extremely cold conditions. Again, anything that is wet and retains moisture will freeze in below-freezing temperatures. A natural turf-grass field with water or moisture throughout its full cross-section will take longer to thaw than a synthetic turf surface due to the mass of the frozen material.
- A well-constructed infill synthetic turf can handle 45 to 60 hours of use per week and can perform for multiple years without a rest season for its full useful life.
- A natural grass field should only be used 15 to 20 hours per week with a rest season. Re-sodding can diminish use hours. A higher level of maintenance and soil testing can help bring these up to 20 to 24 hours per week. The health of a natural turf grass field may require a rest season to maintain optimum performance levels.
- A synthetic turf field needs to have goal mouth areas replaced every four years. This is especially true on fields used for lacrosse.
- A synthetic field will eventually need to be fully replaced. A natural turf grass field may not.

An Owner can expect that one lighted synthetic turf field can provide the same number of use hours as three natural turf grass fields. Synthetic turf fields allow programs to start earlier and extend into later parts of the season without overuse damage typical of high use natural turf grass fields. From and environmental impact perspective having synthetic turf fields in a venue increases the available hours of paly and decreases the amount of land disturbance required to provide the same hours using natural turf grass fields.

Maintenance

Contrary to some beliefs, all fields, natural and synthetic, require maintenance. For natural turf-grass fields, the investment in maintenance is a function of the quality of the field and is greater for the higher quality fields. Because we are focusing on engineered natural turf-grass fields, we will use a higher level of maintenance for this discussion. Keep in mind that a trained natural turf-grass professional should oversee the maintenance and use of a high-quality natural turf-grass field to obtain the best results.

Further maintenance costs for both surface types can increase dramatically as hours of use increase. A high-end, sand-based game-quality field will have a similar installation value to a FIFA Quality Pro field. Its overall cost for testing and maintenance may also be similar due to the FIFA testing requirements.

Another typically overlooked item regarding natural grass maintenance is that the equipment needs to be maintained at its best performance levels. For example, cutting grass with a dull blade can injure the turf grass blade. Synthetic turf maintenance equipment tends to undergo less wear and tear.

Synthetic Turf Maintenance

Synthetic turf requires cleaning weekly, as well as grooming every two weeks or 100 hours of use. It may also require a more aggressive grooming once or twice per year. Frequently used goal mouths can be expected to be replaced once or twice in eight years. The goal mouth areas should be evaluated each week, and areas of low infill should be filled and groomed to even out infill levels.

The synthetic turf system should include a maintenance checklist that must be followed and recorded. Inspection of the turf surface should be a regular activity. During these inspections conditions such as low infill depth and possibly loose field inlays should be noted and corrected. Failure to address these issues can result in more significant use damage in the future. Surface repairs can impact use schedules, but are not as time-consuming as repairs to natural turf-grass fields.

As the hours of use increase due to uses such as summer camps, so does the required maintenance. Sweeping and grooming rates should be increased accordingly. Increased grooming rates may also be due to a desire to have pre-game grooming for sports such as soccer and field hockey, where ball surface performance is critical to play. A field used for lacrosse should have the goal circles checked and adjusted, on a weekly basis for infill migration, which could expose the carpet backing to direct cleat wear.

Natural Turf-Grass Maintenance

Depending on the season, the amount of maintenance for natural turf-grass fields can change significantly. During the first natural turf grass growth seasons, mowing may be required two to three times per week due to higher watering rates. This is a period of high fertilization and maintenance with absolutely **no** use benefit. The recommend grow-in period for a seeded field is a full year. If the field is sodded light use can begin in eight to ten weeks.

Natural turf should include irrigation, mowing one to two times per week, fertilization, pest management programs, both surface and deep tine aeration, overseeding, top dressing, and re-sodding high-use areas on a yearly basis. The time required for surface repairs increases with use on a natural turf grass field.

The following table provides a comparison of the projected hours of maintenance for natural turf grass fields and infill synthetic turf grass fields.

Comparison of Maintenance Hours:

Natural Turf Grass Field - Practice Facility	
Natural Turf Grass Field Yearly Maintenance Hours	
Labor	Man Hours
Mowing	312
Cultural Practices	80
Repairs	80
Structural Practices	80
Painting	200
Total Man Hours	752
Use Hours Per Year (20 Hours Per Week)	1040
Maintenance Hours Per Hour of Use	0.72

Synthetic Infill Field - Stadium Game Field	
Synthetic Turf Field Yearly Maintenance Hours	
Labor	Man Hours
Cleaning	208
Grooming	104
Repairs	40
Topdressing Low Areas	40
Painting	100
Total Man Hours	492
Use Hours Per Year (60 Hours Per Week)	3120
Maintenance Hours Per Hour of Use	0.16

Synthetic turf requires 1/4 the man hours to properly maintain as compared to natural grass.

This comparison normally consists of comparing the total hours per year; however, dividing by the projected hours of use per year provides the maintenance hours per hours of use, which represents a more realistic comparison of maintenance costs. It should be noted that this comparison assumes a high level of maintenance for both field systems.

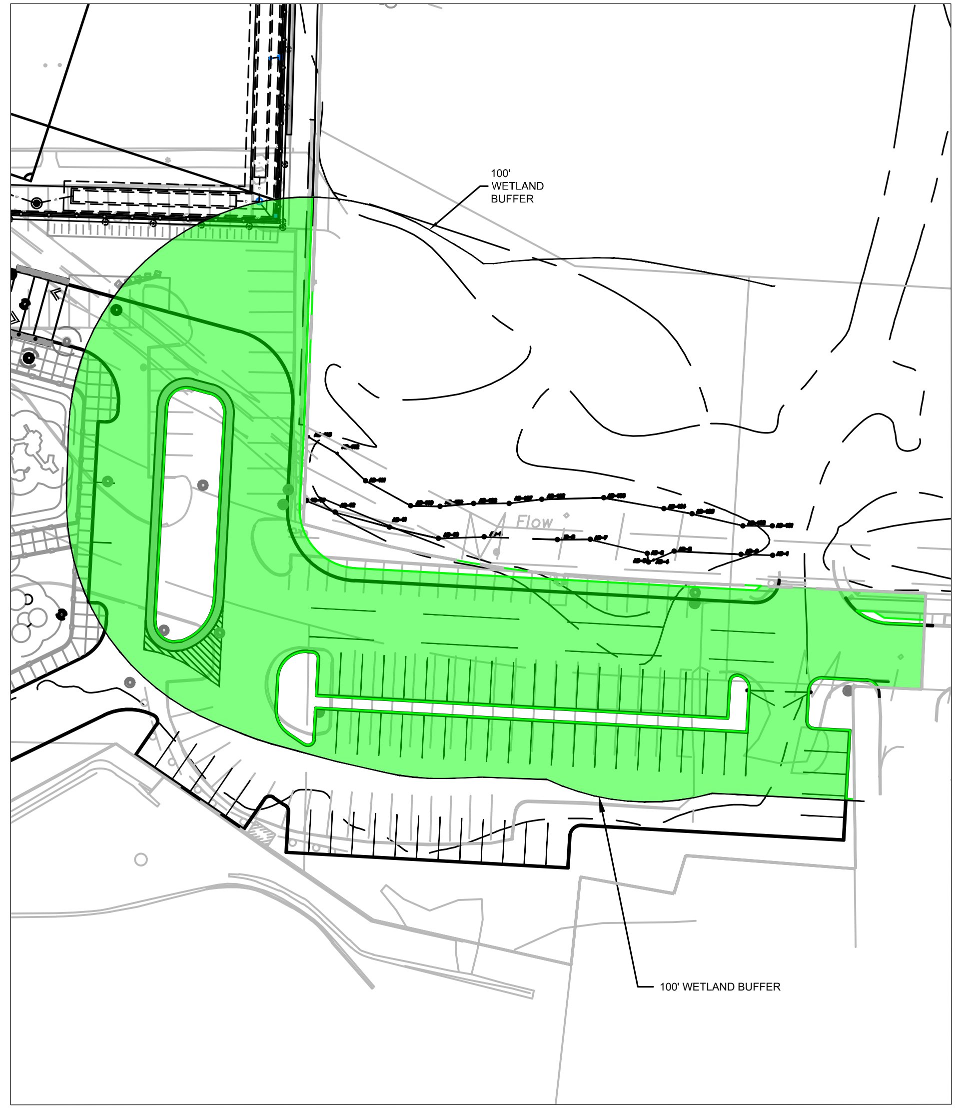
The above table shows that natural turf grass will require approximately 50% more man-hours of maintenance in a typical year than an equivalent size infill synthetic turf field. Taking the yearly projected hours of use for each field type into consideration, the table shows that each hour of maintenance performed on a synthetic turf field results in more hours of actual play.

About JJA Sports, LLC

JJA Sports is a small but productive specialty athletic design boutique. It was founded in 2002 with the goal of providing, start to finish, civil engineering-based, senior-level athletic specialty planning, consulting, and design, as well as athletic surface consulting, to clients ranging from colleges and universities to local recreation and youth programs. Since our founding, we have provided planning, design, and consulting on over 40 natural turf-grass fields and over 75 synthetic turf fields throughout the country, with most of our work in the New England area.

Mr. Amato served two terms as Executive Committee Secretary and has recently begun his second term as Second Vice Chairman of the ASTM F08 Main Committee on Sports Equipment and Facilities. In addition he has served as Vice Chair for ASTM F08.65 Subcommittee on Artificial Turf. Within the Main Committee he has serve on key synthetic turf, natural turf, and running track surfacing subcommittees. Since the late 90's, he has been a participating member of F08, where he assist in updating existing standards, as well as developing new standard test methods and specifications, for the natural and synthetic turf industries. He has participated in developing several standard test methods noted in this report as well as others used throughout the natural and synthetic turf industries.

EXISTING IMPERVIOUS AREA WITHIN AURA = 31,151 SF



PROPOSED IMPERVIOUS AREA WITHIN AURA = 34,665 SF

Sketch No. NOI-100	Job #:	17127.00	Project: ARLINGTON HIGH SCHOOL
	Drawn by:	DJS	
Reference Drawing -	Scale:	1"=80'	Title: AURA IMPERVIOUS AREA
	Date:	06/04/20	EXISTING VS. PROPOSED

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STORMWATER REPORT

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Massachusetts Department of Environmental Protection

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07 May 2020; Revised 28 May 2020

ARLINGTON HIGH SCHOOL
STORMWATER MANAGEMENT NARRATIVE
ARLINGTON, MA

Introduction:

The existing site, located at 869 Massachusetts Avenue, Arlington, MA, consists of the Arlington High School campus, containing the existing Arlington High School Building with an associated paved driveways, landscaped areas, and utilities as well as grass athletic fields, a turf football field, and facilities. There are several accessory structures across the property for equipment storage and bathroom facilities for the fields. The property is abutted by the Minuteman Commuter Bikeway on the north side, a condominum complex, church, and pharmacy on the east side, and a series of residences and the Francis N. O'Hara building on the west side. The site slopes approximately 35 feet from south to north, with the high point of the site being at Massachusetts Ave. and the low point being on the east side of the site at the end of the Mill Brook culvert. Mill Brook flows through the site from west to east between the existing building and the football stadium via a subsurface concrete box culvert. which splits into two corrugated metal culverts on the east side of the existing building before daylighting on the east side of the site adjacent to Mill Street Extension.

The proposed project includes a new 143,025 square foot High School building footprint with associated new paved parking areas, landscaping, athletic fields, bathroom building, utilities and a new stormwater management system in accordance with the Massachusettss DEP Stormwater Standards. The existing football stadium will remain as is and is not within the scope of this project.

Existing Site Hydrology:

In the existing condition, site drainage is handled by a series of "daisy-chained" catch basins that capture stormwater flows and conveys it via underground stormwater piping to the Mill Brook culvert. There is also a large existing culvert, consisting of a 36" reinforced concrete pipe (RCP), that flows under the existing building and discharges to the Mill Brook culvert. This 36" culvert carries a large upgradient offsite watershed from South of the project site that measures over 4,500,000 sf (105+ Ac). See figure within the appendices of this report. Historically this culvert has been shown to be undersized and has caused flooding and floor buckling within the basement of the High School.

From a stormwater treatment perspective, there is an existing oil/water separator unit on the north side of the building, however this structure only treats a single catchment area of a much larger impervious area on-site. The field areas and football stadium have underdrainage system that ties into the Mill Brook culvert as well.

According to FEMA flood mapping, the site is located within Zones X and AE (see FEMA Firmette Map within the appendices of this report). These flood zones are depicted graphically on the civil design plans and existing conditions plans per the FEMA delineation. However, after a field survey of elevations present at the site, we have concluded that the flood elevations shown on the FEMA mapping are held within the banks of the Mill Brook and do not encroach on the site. During the last major renovation at the school, there was a small area on the east side of the school dedicated for compensatory storage.

Methodology/ Procedure

The proposed Stormwater Management system will include several stormwater Best Management Practices (BMPs) consisting of deep sump catch basins, water quality treatment units, an underground

infiltration system, and three (3) lined rain gardens used for filtration. See the Proposed Watersheds section within this report for detailed information about the proposed BMPs for each watershed included in the stormwater management design.

Watershed Routing

Below is a summary of the various existing and proposed watersheds with a brief narrative describing the routing. The watersheds are depicted in sketches Ex-HYD and P-HYD located in the appendices of this report. The hydrology maps show a single point of analysis (POA) in both the existing conditions and the proposed conditions. POA-1 represents the culmination point of stormwater flows across the site within Mill Brook on the east side of the site.

Existing Watersheds:

Ex- Watershed-1: This watershed consists of the existing high school building, fields, paved parking areas and landscaped areas across the site. Stormwater from this watershed sheet flows overland to existing catch basins across the site, which are conveyed via existing underground piping to the existing drainage systems on the north side of the site before discharging to Mill Brook, defined as POA-1.

Proposed Watersheds:

P- Watershed-1: This watershed consists of paved parking areas, pedestrian walkways, and landscaped areas that sheet flow overland to the proposed deep sump catch basins, where it is then conveyed to a proposed water quality unit prior to discharging to the culertized portion of Mill Brook on the east side of the site, defined as Point of Analysis 1 (POA-1).

P- Watershed-1A: This watershed consists of a portion of the paved parking area and landscaped area on the east side of the site. Stormwater sheet flows overland to proposed deep sump catch basins, where it is then conveyed to a proposed water quality unit prior to discharging to Mill Brook on the east side of the site, defined as Point of Analysis 1 (POA-1).

P- Watershed-1B: This watershed consists of the northwest portion of the proposed building. Stormwater is collected and piped underground via roof drain piping to the culvertized portion of Mill Brook, defined as Point of Analysis 1 (POA-1).

P- Watershed-1C: This watershed consists of pedestrian walkways, landscaped areas, and wooded areas on the east edge of the site. Stormwater sheet flows that do not discharge directly to Mill Brook flow overland to the abutting property where they eventually culminate at Mill Brook on the east side of the site, defined as Point of Analysis 1 (POA-1).

P- Watershed-1D: This watershed consists of the southern portion of the proposed building. Stormwater is collected and piped underground via roof drain piping to an existing drain pipe that discharges to Mill Brook on the east side of the site, defined as Point of Analysis 1 (POA-1).

P- Watershed-1E: This watershed consists of pedestrian walkways and landscaped areas that sheet flow overland to the proposed area drains, where it is then conveyed to the culertised portion of Mill Brook on the east side of the site via underground piping, defined as Point of Analysis 1 (POA-1).

P- Watershed-2: This watershed consists of stormwater flows from the parking area, play area, and landscaped area on the east side of the site. Stormwater flows overland to proposed deep sump catch basins and is conveyed via underground pipe to a proposed underground infiltration system (UGS-1). In larger storm events, flows will discharge via an outlet control structure (OCS-1) and underground piping to an existing drain pipe that discharges to Mill Brook, defined as POA-1.

P- Watershed-2B: This watershed consists of the eastern portion of the proposed building. Stormwater is collected and piped underground via roof drain piping to a proposed underground infiltration system (UGS-1). In larger storm events, flows will discharge via an outlet control structure (OCS-1) and underground piping to an existing drain pipe that discharges to Mill Brook, defined as POA-1.

P- Watershed-3A: This watershed consists of paved parking areas, the Shouler Court paved roadway, pedestrian walkways, amphitheater area, and landscaped areas on the west side of the site that sheet flow overland to proposed deep sump catch basins. Stormwater flows are conveyed via underground piping to a proposed lined Rain Garden (RG-1). Stormwater passes through the soil media and the lined bioretention area channels the filtered stormwater through a perforated underdrain pipe at the bottom of the bioretention system that discharges to another proposed Rain Garden (RG-2), which also has an underdrain pipe collecting flow and discharging to the third Rain Garden (RG-3). This bioretention area has an underdrain and outlet control structure (OCS-2) discharging to the stormwater trunk line running along the north side of the proposed building. Flows from this trunk line are discharged to the culvertized portion of Mill Brook on the east side of the site, defined as Point of Analysis 1 (POA-1). Note that the proposed Rain Garden (RG-1) has an emergency spillway weir for larger storm events, which discharges to RG-2.

P- Watershed-3B: This watershed consists of paved parking areas and landscaped areas, as well as flows from the upstream RG-1 (see P-Watershed-3A description) on the west side of the site that sheet flow overland to proposed deep sump catch basins. Stormwater flows are conveyed via underground piping to a proposed lined Rain Garden (RG-2). Stormwater passes through the soil media and the lined rain garden channels the filtered stormwater through a perforated underdrain pipe at the bottom of the rain garden that discharges to another proposed Rain Garden (RG-3), which also has an underdrain pipe and outlet control structure (OCS-2) discharging to the stormwater trunk line running along the north side of the proposed building. Flows from this trunk line are discharged to the culvertized portion of Mill Brook on the east side of the site, defined as Point of Analysis 1 (POA-1). Note that the proposed Rain Garden (RG-2) has an emergency spillway weir for larger storm events, which discharges to RG-3.

P- Watershed-3C: This watershed consists of landscaped areas, as well as flows from the upstream RG-2 (see P-Watershed-3B description) on the west side of the site that sheet flow overland to proposed deep sump catch basins. Stormwater flows are conveyed via underground piping to a proposed lined Rain Garden (RG-3). Stormwater passes through the soil media and the lined rain garden channels the filtered stormwater through a perforated underdrain pipe at the bottom of the rain garden and is collected via an underdrain perforated pipe at the bottom of the rain garden that discharges to the stormwater trunk line running along the north side of the proposed building. Flows from this trunk line are discharged to the culvertized portion of Mill Brook on the east side of the site, defined as Point of Analysis 1 (POA-1). Note that the proposed Rain Garden (RG-3) has an outlet control structure associated with its design for larger storm events, which discharges to the outlet pipe and trunk line.

P- Watershed-4: This watershed consists of pedestrian walkways and synthetic turf soccer field areas on the west side of the site that are collected via underdrain piping and area drains and passed through a series of small detention basins prior to discharging to the trunk line on the north side of the proposed building and ultimately discharging to the culvertized portion of Mill Brook on the east side of the site, defined as Point of Analysis 1 (POA-1).

P- Watershed-5: This watershed consists of pedestrian walkways and synthetic turf baseball field areas on the east side of the site that are collected via underdrain piping and area drains and passed through a series of small detention basins prior to discharging to the culvertized portion of Mill Brook on the east side of the site, defined as Point of Analysis 1 (POA-1).

Flood Storage

As discussed previously within this report the site is graphically located within Flood Zones X and AE per FEMA mapping, but the actual elevations per the Flood Impact Study occur within the banks of the Mill Brook. There is a small compensatory storage area on the east side of the existing building that was for a previous project but not defined by elevations or compensatory storage volumes. This area will be disturbed by the proposed High School project. The proposed project even though not within flood plain elevations will emulate the existing compensatory storage by providing compensatory storage within the stone of the turf fields that far exceed the volume held by the existing flood storage area.

Results/ Summary

Analysis:
The analysis was based on the pre and post development peak discharge rates at the point of analysis. The proposed construction of the school campus will result in an increase in impervious area, therefore the proposed stormwater management system will be designed to mitigate any increase in the rate of runoff and improve stormwater quality in accordance with the requirements of the Massachusetts Stormwater Management Policy Standards.

Results of Analysis:
Through the use of the HydroCAD Software, the curve numbers, times of concentrations, and peak discharge rates were determined for both the existing conditions and the proposed conditions. The results of the study shows that both the post-development peak rates of runoff are equal or less than the existing rates. The rainfall data used to develop the analysis in Table 1 is based on NOAA Atlas 14 point precipitation frequency estimates for the site.

As shown in Table 1, the post development peak rates of runoff from the site to each POA will be mitigated.

Table 1 – POA-1 : Peak Rates of Runoff

	2-year storm (cfs)	10-year storm (cfs)	25-year storm (cfs)	100-year storm (cfs)
Existing	22.53	49.33	67.06	94.91
Proposed	21.54	46.88	64.17	86.42

Stormwater Management Standards

The Department of Environmental Protection has implemented the Stormwater Management Standards as of November 18, 1996 and updated them in April 2008. The standards met are described below and in the Stormwater Management Form as provided by DEP.

Standard #1: Untreated Stormwater

The project is designed so that stormwater conveyances (outfalls/discharges) do not discharge untreated stormwater into, or cause erosion to, wetlands or waters.

Therefore Standard #1 is met.

Standard #2: Post-development peak discharge rates

The proposed construction of Arlington High School will result in an overall site increase in impervious area. The proposed stormwater management system has been designed so that there is no increase in post construction discharge rates from the site for each point of analysis by the introduction of stormwater BMPS such as bioretention areas and underground infiltration basins. See Table 1 of this report for existing and proposed flows to the Point of Analysis, showing that Standard #2 is met.

Therefore Standard #2 is met.

Standard #3: Recharge to groundwater

Loss of annual recharge to groundwater shall be eliminated or minimized through the use of environmentally sensitive site design, stormwater best management practices, and good operation and maintenance procedures. At a minimum, the annual recharge from the post- development site shall approximate the annual recharge from pre-development conditions based on soil type. This Standard is met when the stormwater management system is designed to infiltrate the required recharge volume as determined in accordance with the Massachusetts Stormwater Handbook.

Soil types have been identified based on the information contained in the Soil Report (see Soil Report within appendices of this report). Based on the available soil information provided in the appendices of this report, we have determined that the soils are consistent with Hydrologic soil type “B” which require runoff to be infiltrated (as listed in the table below) from new impervious areas. Test pit data from testing done on site confirms the Soil Report information in the appendices of this report.

Hydrologic Group Volume to Recharge x (Total Impervious Area)	
Hydrologic Group	Volume to Recharge x Total Impervious Area
A	0.60 inches of runoff
B	0.35 inches of runoff
C	0.25 inches of runoff
D	0.10 inches of runoff

<u>“B” Soils</u>

Infiltration Rate: 0.35 inches of runoff
Existing Impervious Area: 7.78 Ac. (338,984 sf)
Proposed Impervious Area: 8.63 Ac. (375,923 sf)
Proposed Site New Impervious Area in “B” Soils: 36,939 sf
36,939 sf x 0.35 x (1/12) = 1,077 cf

Total required recharge volume: 1,077 cf

Proposed Recharge Volume:
Infiltration System UGS-1 = 3,251 cf

Total provided recharge volume: 3,251 cf

Drawdown Time:

UGS-1 (maximum time 72 hours)= 3,251 cf / (1.02 in/hr x 1,672 sf / 12 in/ft) = 22.88 hours

Therefore Standard #3 is met.

Standard #4: TSS removal

The BMP's selected to remove TSS from impervious areas for this include: Deep Sump Catch Basins (CB), Water Quality Units (WQU), three (3) bioretention areas & an Infiltration System (UGS-1). Building roof runoff is considered "clean" and therefore does not require TSS removal.

P-Watershed-1: (Parking, Walkways)
Deep Sump Catch Basin: (1.00)(1.00-0.25)= 0.75
Water Quality Unit: (0.75)(1.00-0.80)=0.15
Total TSS Removal= 85%

P-Watershed-1A: (Parking, Walkways)
Deep Sump Catch Basin: (1.00)(1.00-0.25)= 0.75
Water Quality Unit: (0.75)(1.00-0.80)=0.15
Total TSS Removal= 85%

P-Watershed-2: (Parking, Walkways)
Deep Sump Catch Basin: (1.00)(1.00-0.25)= 0.75
Infiltration Basin: (0.75)(1.00-0.80)=0.15
Total TSS Removal= 85%

P-Watershed-3A: (Parking, Walkways)
Deep Sump Catch Basin: (1.00)(1.00-0.25)= 0.75
Bioretention Area: (0.75)(1.00-0.90)=0.075
Bioretention Area: (0.08)(1.00-0.90)=0.008
Bioretention Area: (0.01)(1.00-0.90)=0.001
Total TSS Removal= 99.9%

P-Watershed-3B: (Parking)
Deep Sump Catch Basin: (1.00)(1.00-0.25)= 0.75
Bioretention Area: (0.75)(1.00-0.90)=0.075
Bioretention Area: (0.08)(1.00-0.90)=0.008
Total TSS Removal= 99%

Water Quality Volume:

The project qualifies for the 0.5" runoff rate applied to the total impervious area for the water quality volume, as shown in the calculations provided below. The calculations for the infiltration stormwater BMPs are shown below. Where site topography and groundwater elevation precluded the use of infiltration BMPs, proprietary water quality unit are proposed which are specifically designed to address water quality prior to discharge. Roof runoff is considered "clean" and has therefore been excluded from this calculation.

Impervious area requiring water quality treatment= 82,241 sf
82,241 sf * .0417 ft = 3,429 CF

Total Water Quality Volume Required = 3,429 CF

Proposed Water Quality Volume:
Infiltration System UGS-1 = 3,251 cf
Bioretention System RG-1 = 551 cf
Bioretention System RG-2 = 1,200 cf
Bioretention System RG-3 =2,283 cf

Total provided water quality volume: 7,285 cf

Therefore Standard #4 is met.

Standard #5: Higher potential pollutant loads

The project site does not contain Land Uses with Higher Potential Pollutant Loads, therefore Standard #5 is met.

Standard #6: Protection of critical areas

Critical areas are Outstanding Resource Waters (ORW) as designated in 314 CMR 4.00, Special Resource Waters as designated in 314 CMR 4.00, recharge areas for public water supplies as defined in 310 CMR 22.02 (Zone Is, Zone IIs and Interim Wellhead Protection Areas for groundwater sources and Zone As for surface water sources), bathing beaches as defined in 105 CMR 445.000, cold-water fisheries as defined in 314 CMR 9.02 and 310 CMR 10.04, and shellfish growing areas as defined in 314 CMR 9.02 and 310 CMR 10.04.

The site is not located within critical areas, therefore Standard #6 is met.

Standard #7: Redevelopment projects

While a portion of the site is being redeveloped, there is an increase in impervious area, thus the project is considered New Construction and all of the Standards will be met.

Standard #8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

Soil Erosion and Sediment Control Plan:
The objectives of the Soil Erosion and Sediment Control Plan are to control erosion at its source with temporary control structures, minimize the runoff from areas of disturbance, and de-concentrate and distribute stormwater runoff through natural vegetation before discharge to critical zones such as streams or wetlands. Soil erosion control does not begin with the perimeter sediment trap. It begins at the source of the sediment, the disturbed land areas, and extends down to the control structure.

The Soil Erosion and Sediment Control Plan will be enacted in order to protect the resource areas during construction. The erosion control devices will remain in place until all exposed areas have been stabilized with vegetation or impervious surfaces.

The objective of the Soil Erosion & Sediment Control Plan that will be enacted on site is to control the vulnerability of the soil to the erosion process or the capability of moving water to detach soil particles during the construction phase(s).

The soil erosion and sediment control BMP's for the site are straw wattles with silt fence, catch basin filters, and a construction entrance as shown on design plans prepared by Samiotes Consultants, In

Therefore Standard #8 is met.

Standard #9: Operation/maintenance plan

An operation and maintenance plan for both construction and post-development stormwater controls has been developed. The plan includes owner(s); parties responsible for operation and maintenance; schedule for inspection and maintenance; routine and non-routine maintenance tasks. A copy of the O&M is included in the appendices of this report.

Therefore Standard #9 is met.

Standard #10: All illicit discharges to the stormwater management system are prohibited

It is not anticipated that there will be any Illicit discharges for the project as it will be new construction, therefore Standard #10 is met.

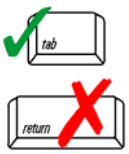
P:\Projects\2017\17211.00 Arlington HS, 869 Mass Ave (Civil)\Documents\Hydrology

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals.[1] This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8[2]
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

---

[1] The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

[2] For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Registered Professional Engineer Block and Signature

5/7/20

Signature and Date

Checklist

Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?

- [ ] New development
- [ ] Redevelopment
- [x] Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

LID Measures: Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

☒ No disturbance to any Wetland Resource Areas

☐ Site Design Practices (e.g. clustered development, reduced frontage setbacks)

☐ Reduced Impervious Area (Redevelopment Only)

☐ Minimizing disturbance to existing trees and shrubs

☐ LID Site Design Credit Requested:

- ☐ Credit 1
- ☐ Credit 2
- ☐ Credit 3

☐ Use of "country drainage" versus curb and gutter conveyance and pipe

☒ Bioretention Cells (includes Rain Gardens)

☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)

☐ Treebox Filter

☐ Water Quality Swale

☐ Grass Channel

☐ Green Roof

☐ Other (describe): ____________________

Standard 1: No New Untreated Discharges

☒ No new untreated discharges

☒ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth

☒ Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist (continued)

Standard 2: Peak Rate Attenuation

☐ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.

☐ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.

☒ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

☐ Required Recharge volume reduced through use of the LID site Design Credits.

☒ Sizing the infiltration, BMPs is based on the following method: Check the method used.

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

☐ Runoff from all impervious areas at the site discharging to the infiltration BMP.

☒ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.

☒ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:

- ☐ Site is comprised solely of C and D soils and/or bedrock at the land surface
- ☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
- ☐ Solid Waste Landfill pursuant to 310 CMR 19.000
- ☐ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

☒ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.

☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

[1] 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

Checklist (continued)

Standard 3: Recharge (continued)

☐ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.

☐ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

The Long-Term Pollution Prevention Plan typically includes the following:

- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.

☒ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.

☐ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:

  ☐ is within the Zone II or Interim Wellhead Protection Area

  ☐ is near or to other critical areas

  ☐ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)

  ☐ involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

☒ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

☒ The BMP is sized (and calculations provided) based on:

- ☒ The ½" or 1" Water Quality Volume or
- ☐ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.

☒ The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.

☐ A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)

☐ The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.

☒ The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted ***prior to*** the discharge of stormwater to the post-construction stormwater BMPs.

☐ The NPDES Multi-Sector General Permit does ***not*** cover the land use.

☐ LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.

☐ All exposure has been eliminated.

☐ All exposure has ***not*** been eliminated and all BMPs selected are on MassDEP LUHPPL list.

☐ The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas

☐ The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.

☐ Critical areas and BMPs are identified in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable

☒ The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:

- ☐ Limited Project
- ☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
- ☐ Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
- ☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
- ☐ Bike Path and/or Foot Path
- ☐ Redevelopment Project
- ☒ Redevelopment portion of mix of new and redevelopment.

☐ Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.

☐ The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.

☒ A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.

Checklist (continued)

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control (continued)

☐ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has ***not*** been included in the Stormwater Report but will be submitted ***before*** land disturbance begins.

☐ The project is ***not*** covered by a NPDES Construction General Permit.

☐ The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.

☒ The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

☒ The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:

- ☒ Name of the stormwater management system owners;
- ☒ Party responsible for operation and maintenance;
- ☒ Schedule for implementation of routine and non-routine maintenance tasks;
- ☒ Plan showing the location of all stormwater BMPs maintenance access areas;
- ☐ Description and delineation of public safety features;
- ☐ Estimated operation and maintenance budget; and
- ☒ Operation and Maintenance Log Form.

☐ The responsible party is ***not*** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:

- ☐ A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
- ☐ A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

Standard 10: Prohibition of Illicit Discharges

☐ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

☐ An Illicit Discharge Compliance Statement is attached;

☒ NO Illicit Discharge Compliance Statement is attached but will be submitted ***prior to*** the discharge of any stormwater to post-construction BMPs.

APPENDIX 1:
Existing Hydrology Calculations

APPENDIX 2:
Proposed Hydrology Calculations

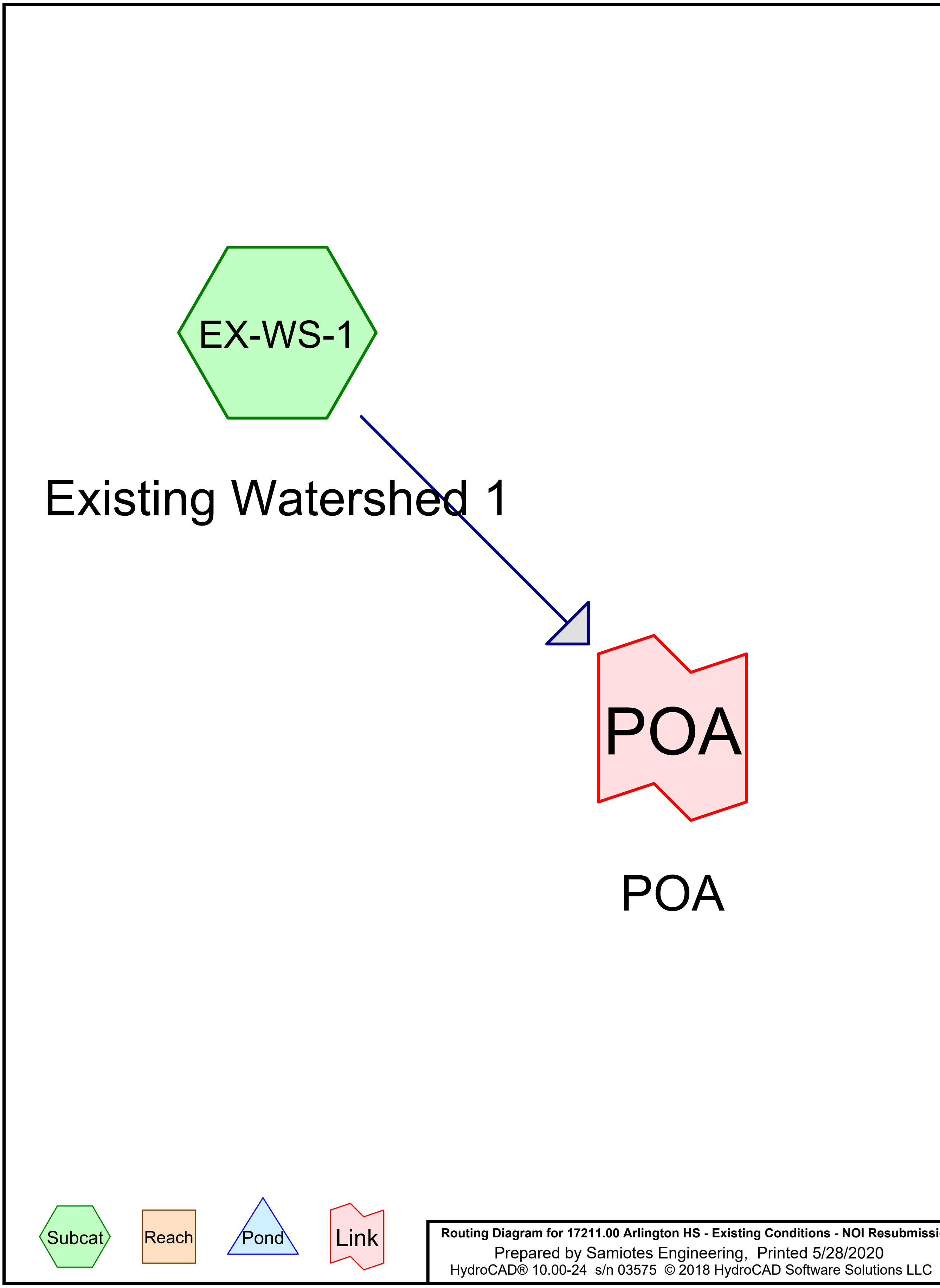
APPENDIX 3:
Test Pit Logs
Soils Report

APPENDIX 4:
Operations and Maintenance Plan

APPENDIX 5:
Calculations

APPENDIX 6:
Sketches

APPENDIX 1:
Existing Hydrology Calculations



Routing Diagram for 17211.00 Arlington HS - Existing Conditions - NOI Resubmission
Prepared by Samiotes Engineering, Printed 5/28/2020
HydroCAD® 10.00-24 s/n 03575 © 2018 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
9.598	61	>75% Grass cover, Good, HSG B (EX-WS-1)
5.051	98	Impervious (EX-WS-1)
2.731	98	Roofs, HSG B (EX-WS-1)
0.020	55	Woods, Good, HSG B (EX-WS-1)
17.400	**78**	**TOTAL AREA**

Summary for Subcatchment EX-WS-1: Existing Watershed 1

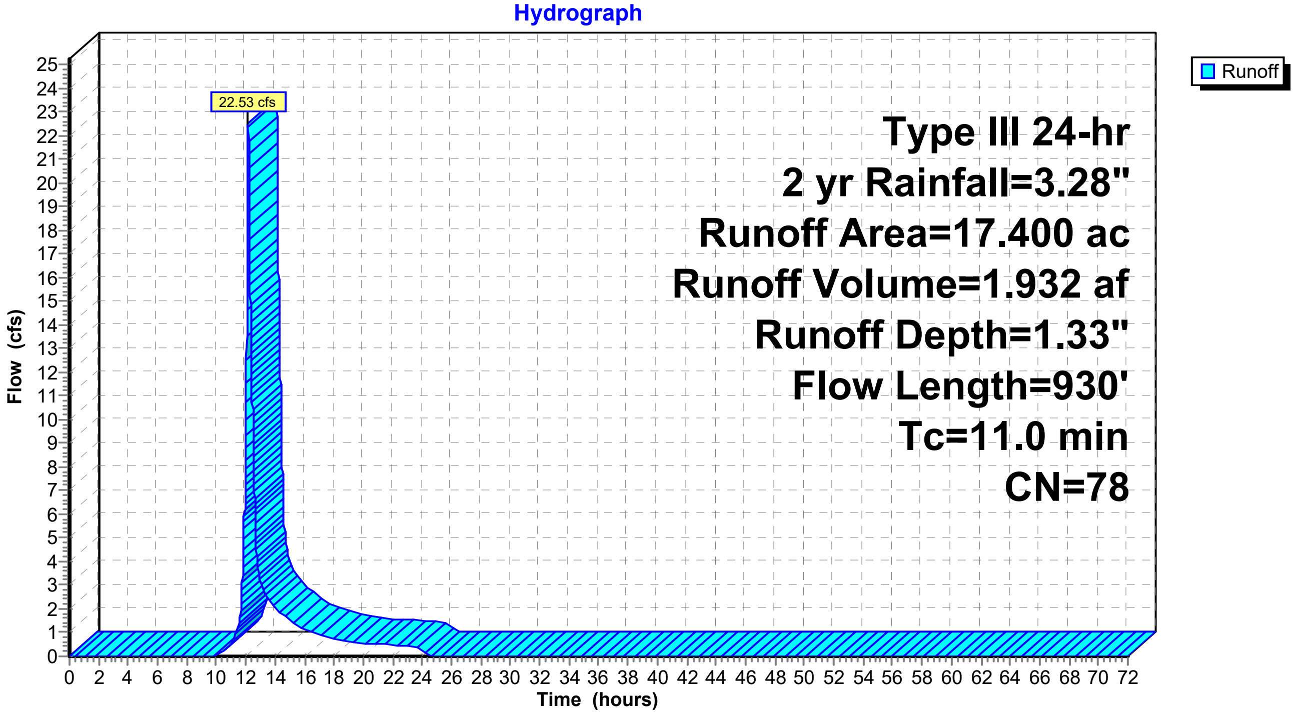
Runoff = 22.53 cfs @ 12.16 hrs, Volume= 1.932 af, Depth= 1.33"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2 yr Rainfall=3.28"

	Area (ac)	CN	Description
*	5.051	98	Impervious
	2.731	98	Roofs, HSG B
	9.598	61	>75% Grass cover, Good, HSG B
	0.020	55	Woods, Good, HSG B
	17.400	78	Weighted Average
	9.618		55.28% Pervious Area
	7.782		44.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.4	50	0.0100	0.11		**Sheet Flow, 50' SF** Grass: Short n= 0.150 P2= 3.20"
1.9	220	0.0140	1.90		**Shallow Concentrated Flow, 220' SCF** Unpaved Kv= 16.1 fps
0.9	140	0.0150	2.49		**Shallow Concentrated Flow, 140' SCF (paved)** Paved Kv= 20.3 fps
0.1	20	0.0100	4.91	3.86	**Pipe Channel, 12" Pipe Flow** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012
0.7	500	0.0050	11.67	466.77	**Pipe Channel, Box Culvert Flow** 96.0" x 60.0" Box Area= 40.0 sf Perim= 26.0' r= 1.54' n= 0.012
11.0	930	Total			

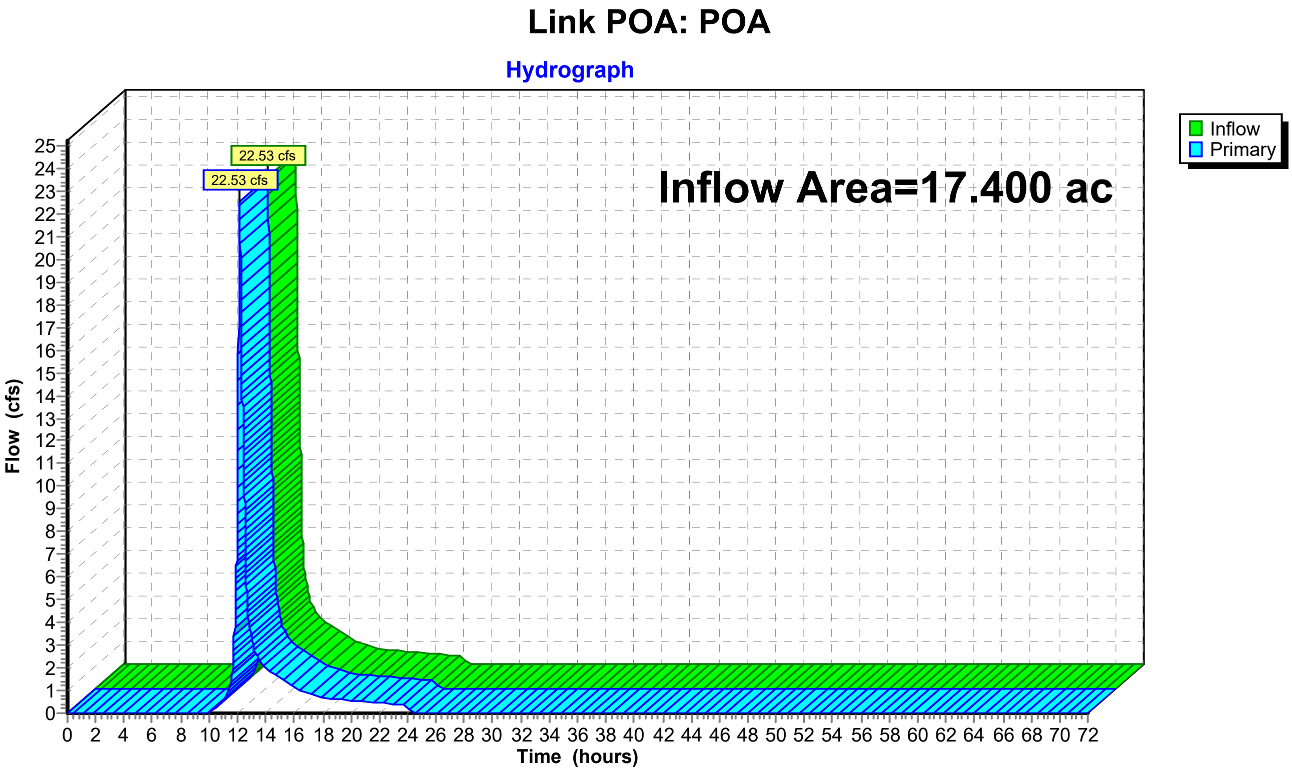
Subcatchment EX-WS-1: Existing Watershed 1



Summary for Link POA: POA

Inflow Area = 17.400 ac, 44.72% Impervious, Inflow Depth = 1.33" for 2 yr event
Inflow = 22.53 cfs @ 12.16 hrs, Volume= 1.932 af
Primary = 22.53 cfs @ 12.16 hrs, Volume= 1.932 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs



Summary for Subcatchment EX-WS-1: Existing Watershed 1

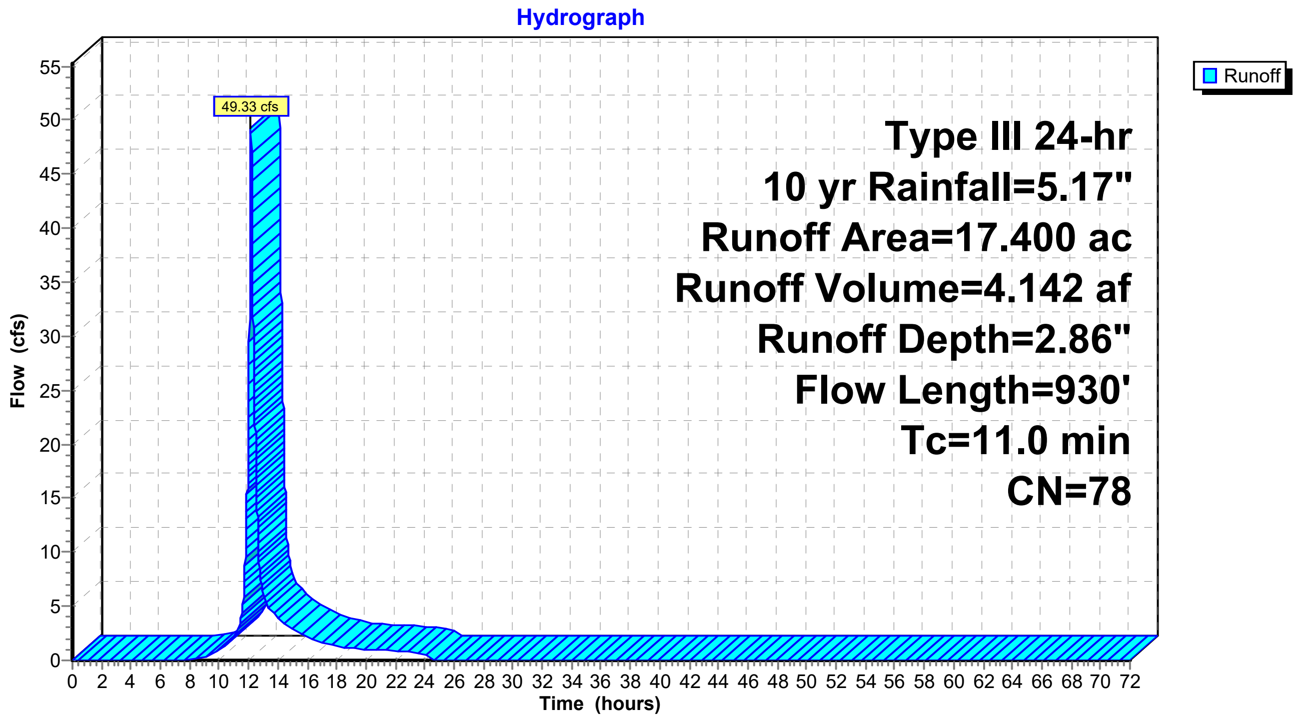
Runoff = 49.33 cfs @ 12.15 hrs, Volume= 4.142 af, Depth= 2.86"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 yr Rainfall=5.17"

	Area (ac)	CN	Description
*	5.051	98	Impervious
	2.731	98	Roofs, HSG B
	9.598	61	>75% Grass cover, Good, HSG B
	0.020	55	Woods, Good, HSG B
	17.400	78	Weighted Average
	9.618		55.28% Pervious Area
	7.782		44.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.4	50	0.0100	0.11		**Sheet Flow, 50' SF** Grass: Short n= 0.150 P2= 3.20"
1.9	220	0.0140	1.90		**Shallow Concentrated Flow, 220' SCF** Unpaved Kv= 16.1 fps
0.9	140	0.0150	2.49		**Shallow Concentrated Flow, 140' SCF (paved)** Paved Kv= 20.3 fps
0.1	20	0.0100	4.91	3.86	**Pipe Channel, 12" Pipe Flow** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012
0.7	500	0.0050	11.67	466.77	**Pipe Channel, Box Culvert Flow** 96.0" x 60.0" Box Area= 40.0 sf Perim= 26.0' r= 1.54' n= 0.012
11.0	930	Total			

Subcatchment EX-WS-1: Existing Watershed 1

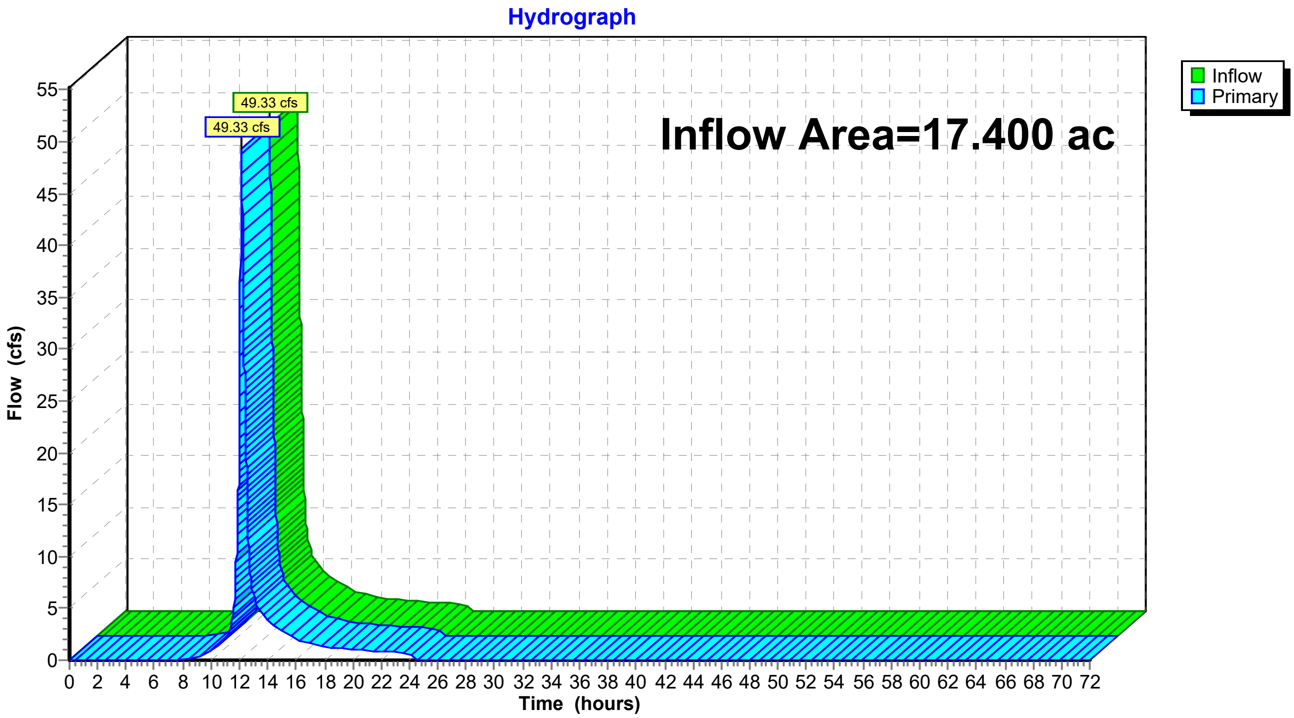


Summary for Link POA: POA

Inflow Area = 17.400 ac, 44.72% Impervious, Inflow Depth = 2.86" for 10 yr event
Inflow = 49.33 cfs @ 12.15 hrs, Volume= 4.142 af
Primary = 49.33 cfs @ 12.15 hrs, Volume= 4.142 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link POA: POA



Summary for Subcatchment EX-WS-1: Existing Watershed 1

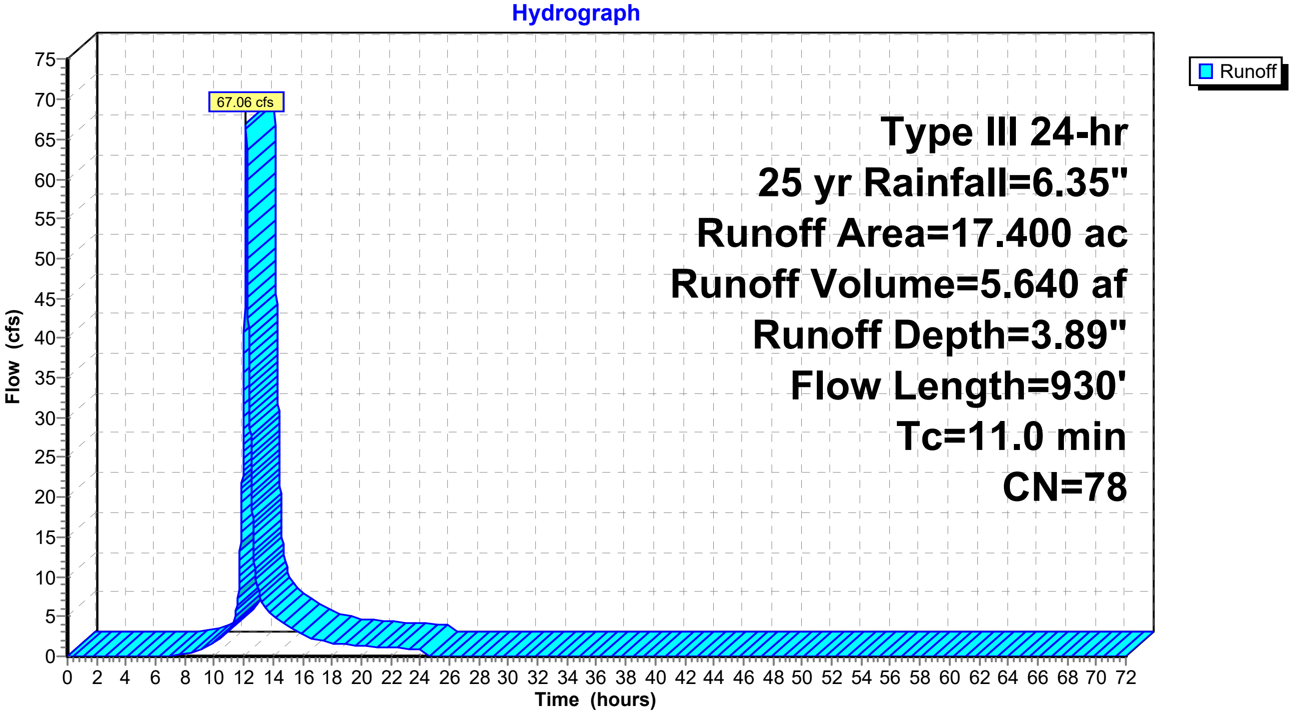
Runoff = 67.06 cfs @ 12.15 hrs, Volume= 5.640 af, Depth= 3.89"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 25 yr Rainfall=6.35"

	Area (ac)	CN	Description
*	5.051	98	Impervious
	2.731	98	Roofs, HSG B
	9.598	61	>75% Grass cover, Good, HSG B
	0.020	55	Woods, Good, HSG B
	17.400	78	Weighted Average
	9.618		55.28% Pervious Area
	7.782		44.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.4	50	0.0100	0.11		**Sheet Flow, 50' SF** Grass: Short n= 0.150 P2= 3.20"
1.9	220	0.0140	1.90		**Shallow Concentrated Flow, 220' SCF** Unpaved Kv= 16.1 fps
0.9	140	0.0150	2.49		**Shallow Concentrated Flow, 140' SCF (paved)** Paved Kv= 20.3 fps
0.1	20	0.0100	4.91	3.86	**Pipe Channel, 12" Pipe Flow** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012
0.7	500	0.0050	11.67	466.77	**Pipe Channel, Box Culvert Flow** 96.0" x 60.0" Box Area= 40.0 sf Perim= 26.0' r= 1.54' n= 0.012
11.0	930	Total			

Subcatchment EX-WS-1: Existing Watershed 1

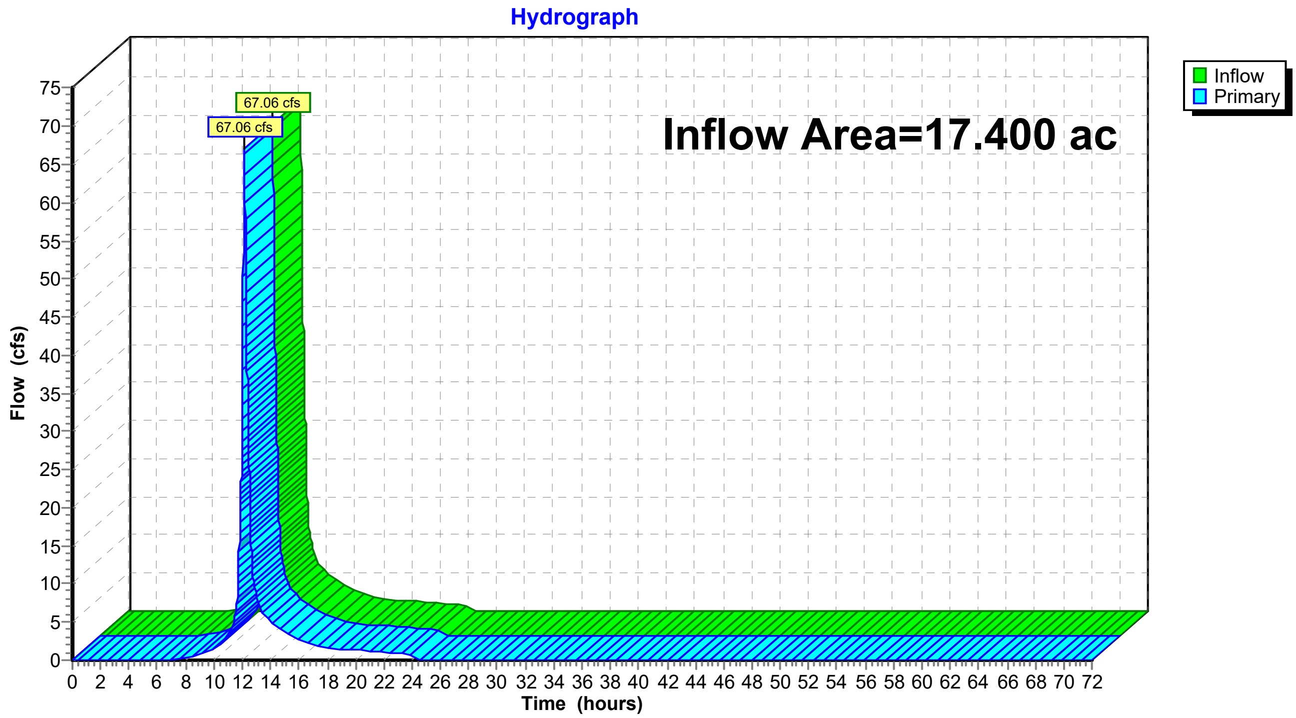


Summary for Link POA: POA

Inflow Area = 17.400 ac, 44.72% Impervious, Inflow Depth = 3.89" for 25 yr event
Inflow = 67.06 cfs @ 12.15 hrs, Volume= 5.640 af
Primary = 67.06 cfs @ 12.15 hrs, Volume= 5.640 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link POA: POA



Summary for Subcatchment EX-WS-1: Existing Watershed 1

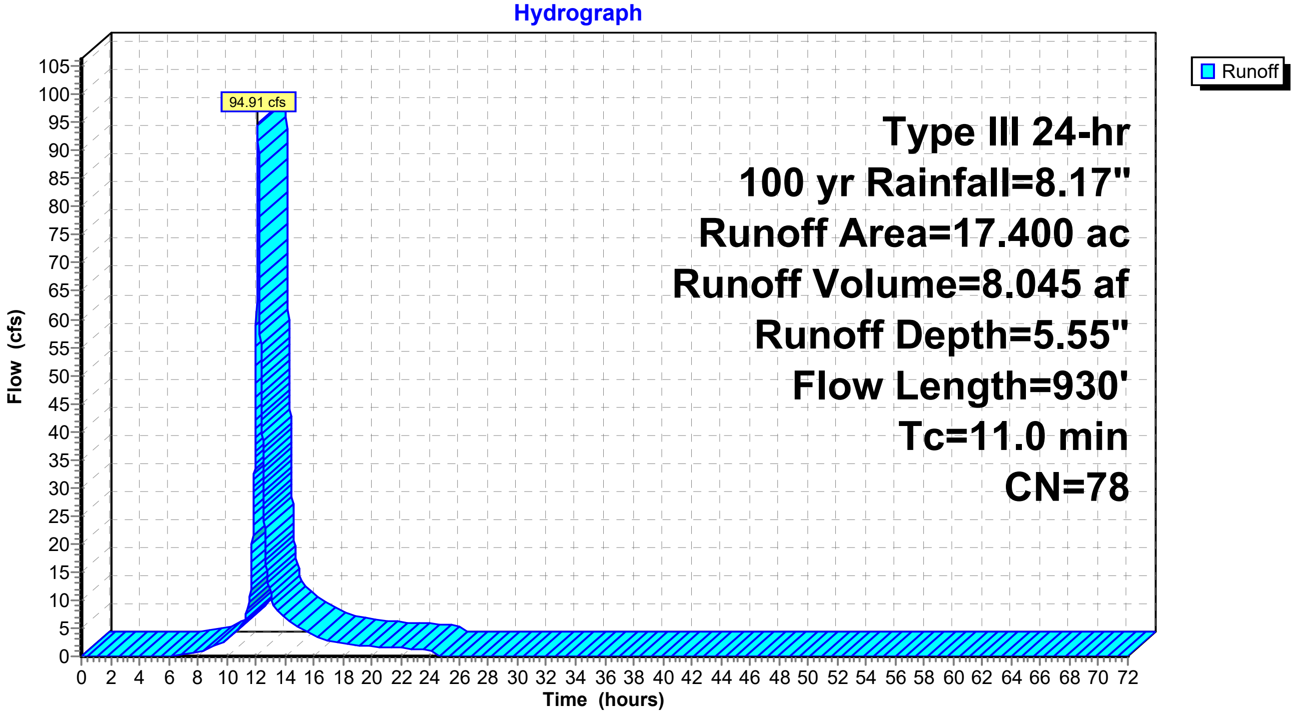
Runoff = 94.91 cfs @ 12.15 hrs, Volume= 8.045 af, Depth= 5.55"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 yr Rainfall=8.17"

	Area (ac)	CN	Description
*	5.051	98	Impervious
	2.731	98	Roofs, HSG B
	9.598	61	>75% Grass cover, Good, HSG B
	0.020	55	Woods, Good, HSG B
	17.400	78	Weighted Average
	9.618		55.28% Pervious Area
	7.782		44.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.4	50	0.0100	0.11		**Sheet Flow, 50' SF** Grass: Short n= 0.150 P2= 3.20"
1.9	220	0.0140	1.90		**Shallow Concentrated Flow, 220' SCF** Unpaved Kv= 16.1 fps
0.9	140	0.0150	2.49		**Shallow Concentrated Flow, 140' SCF (paved)** Paved Kv= 20.3 fps
0.1	20	0.0100	4.91	3.86	**Pipe Channel, 12" Pipe Flow** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012
0.7	500	0.0050	11.67	466.77	**Pipe Channel, Box Culvert Flow** 96.0" x 60.0" Box Area= 40.0 sf Perim= 26.0' r= 1.54' n= 0.012
11.0	930	Total			

Subcatchment EX-WS-1: Existing Watershed 1

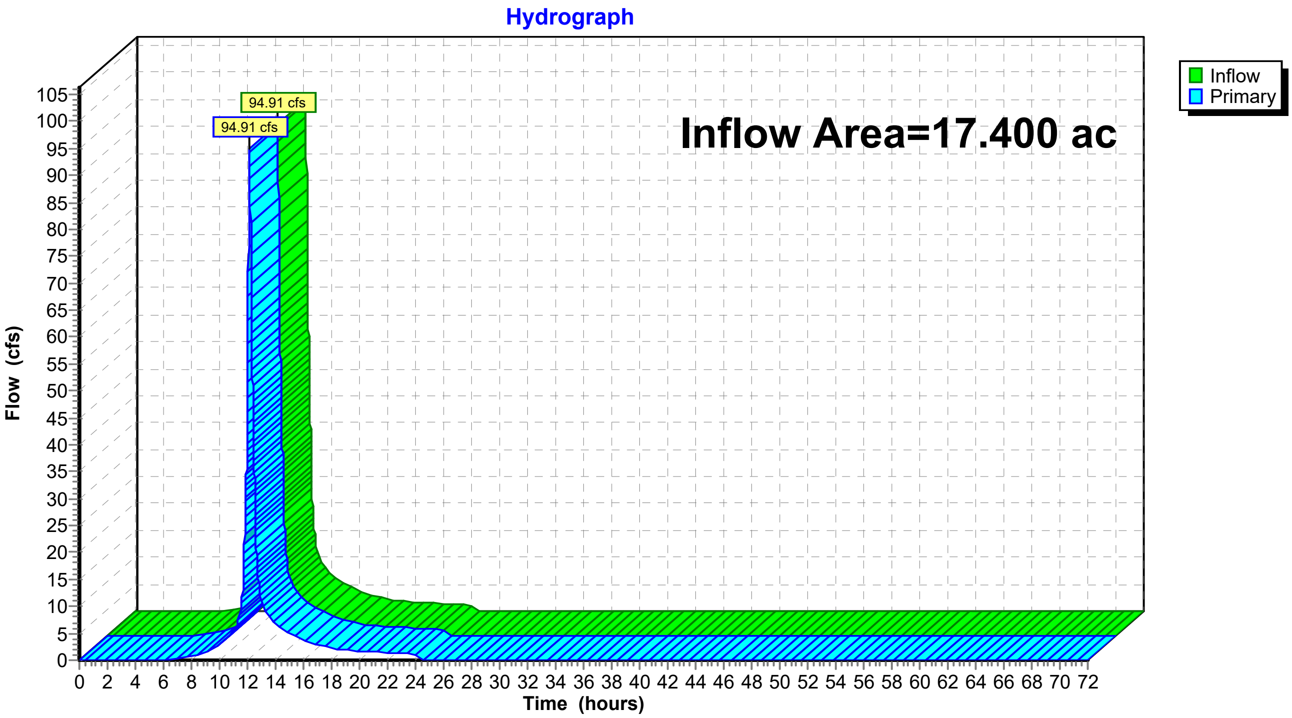


Summary for Link POA: POA

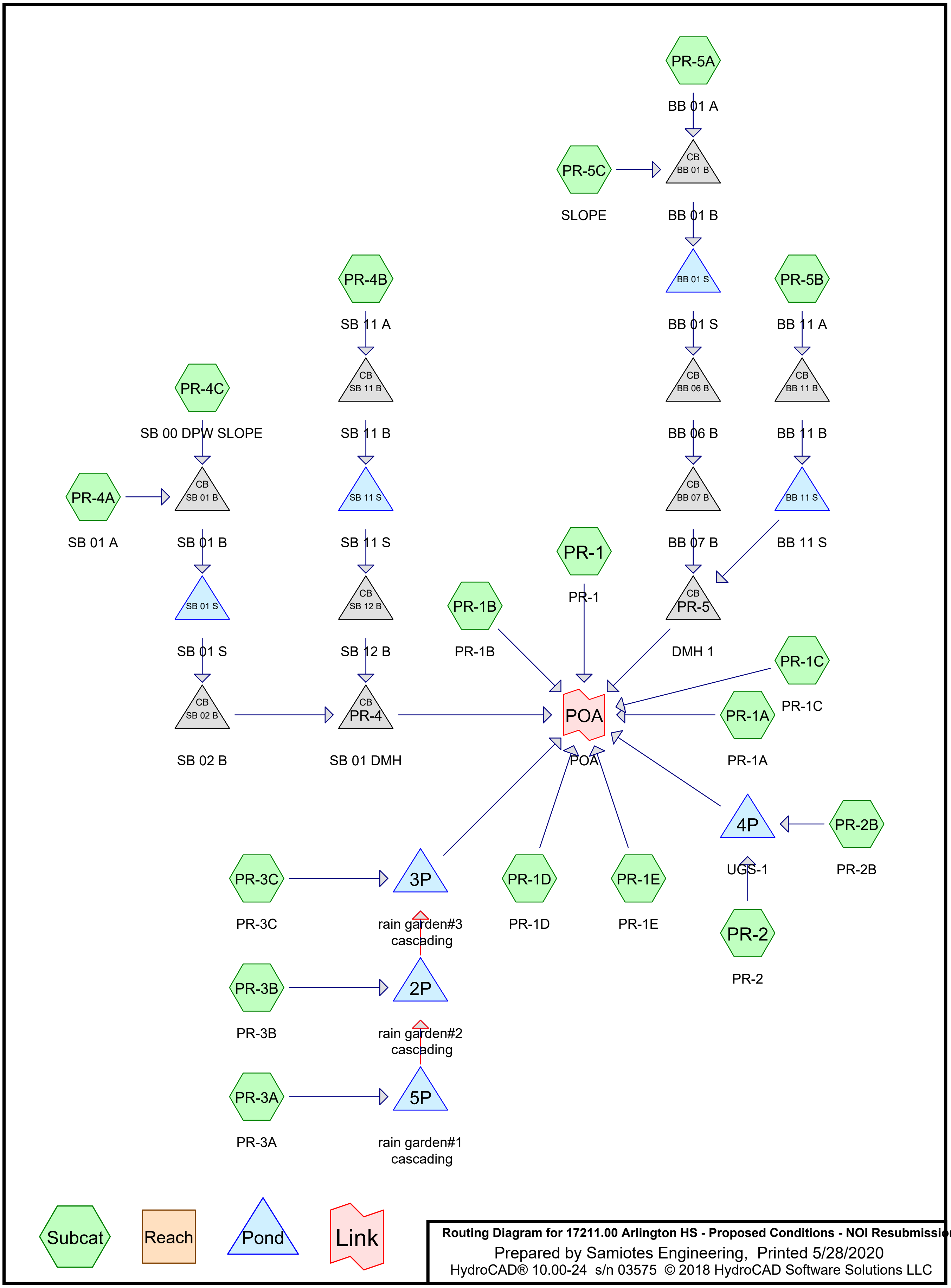
Inflow Area = 17.400 ac, 44.72% Impervious, Inflow Depth = 5.55" for 100 yr event
Inflow = 94.91 cfs @ 12.15 hrs, Volume= 8.045 af
Primary = 94.91 cfs @ 12.15 hrs, Volume= 8.045 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link POA: POA



APPENDIX 2:
Proposed Hydrology Calculations



Routing Diagram for 17211.00 Arlington HS - Proposed Conditions - NOI Resubmission
Prepared by Samiotes Engineering, Printed 5/28/2020
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Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
4.473	61	>75% Grass cover, Good, HSG B (PR-1, PR-1A, PR-1C, PR-1E, PR-2, PR-3A, PR-3B, PR-3C)
0.220	74	>75% Grass cover, Good, HSG C (PR-4C, PR-5C)
4.964	98	Paved parking, HSG B (PR-1, PR-1A, PR-1C, PR-1E, PR-2, PR-3A, PR-3B)
3.627	98	Roofs, HSG B (PR-1B, PR-1D, PR-2B)
4.056	85	SYNTHETIC TURF- PAD- LINER (PR-4A, PR-4B, PR-5A, PR-5B)
0.025	98	Unconnected pavement, HSG A (PR-4C)
0.014	98	Unconnected roofs, HSG C (PR-5C)
0.020	55	Woods, Good, HSG B (PR-1C)
17.400	**85**	**TOTAL AREA**

Summary for Subcatchment PR-1: PR-1

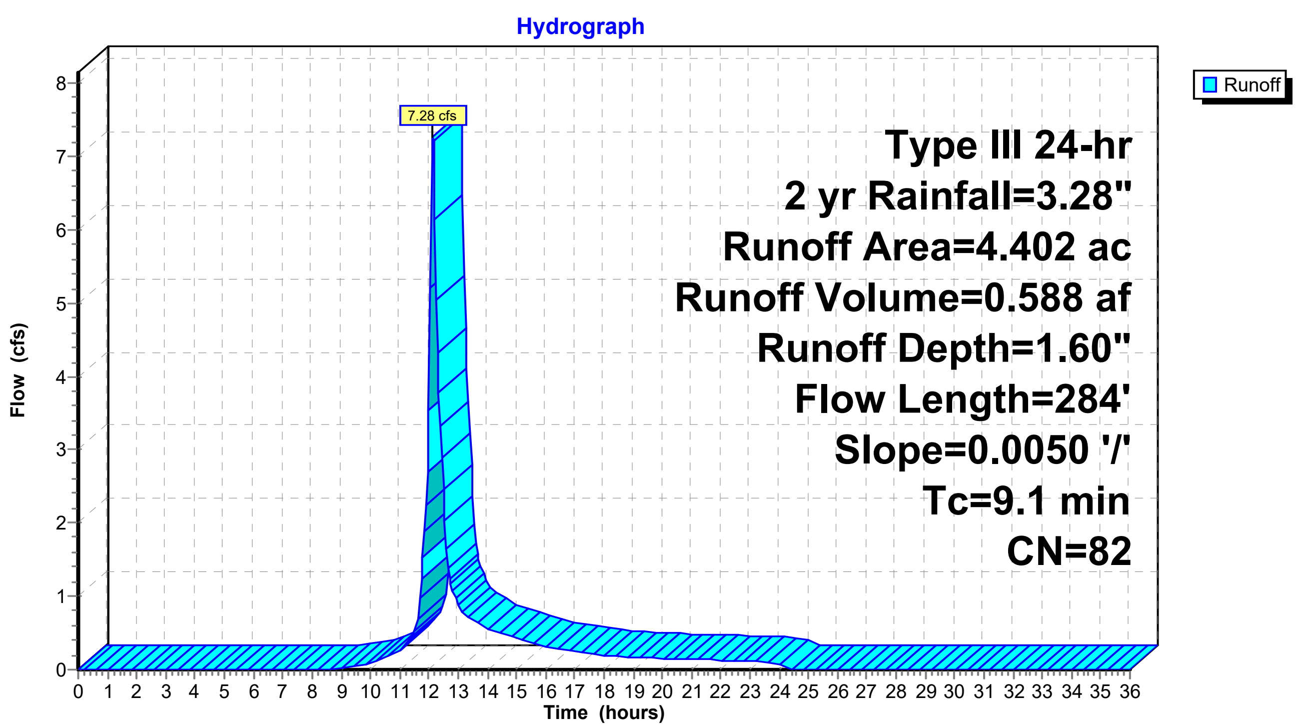
Runoff = 7.28 cfs @ 12.13 hrs, Volume= 0.588 af, Depth= 1.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.28"

Area (ac)	CN	Description
1.892	61	>75% Grass cover, Good, HSG B
2.510	98	Paved parking, HSG B
4.402	82	Weighted Average
1.892		42.98% Pervious Area
2.510		57.02% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	50	0.0050	0.69		**Sheet Flow, A-B**
					Smooth surfaces n= 0.011 P2= 3.20"
7.9	234	0.0050	0.49		**Shallow Concentrated Flow, B-C**
					Short Grass Pasture Kv= 7.0 fps
9.1	284	Total			

Subcatchment PR-1: PR-1



Summary for Subcatchment PR-1A: PR-1A

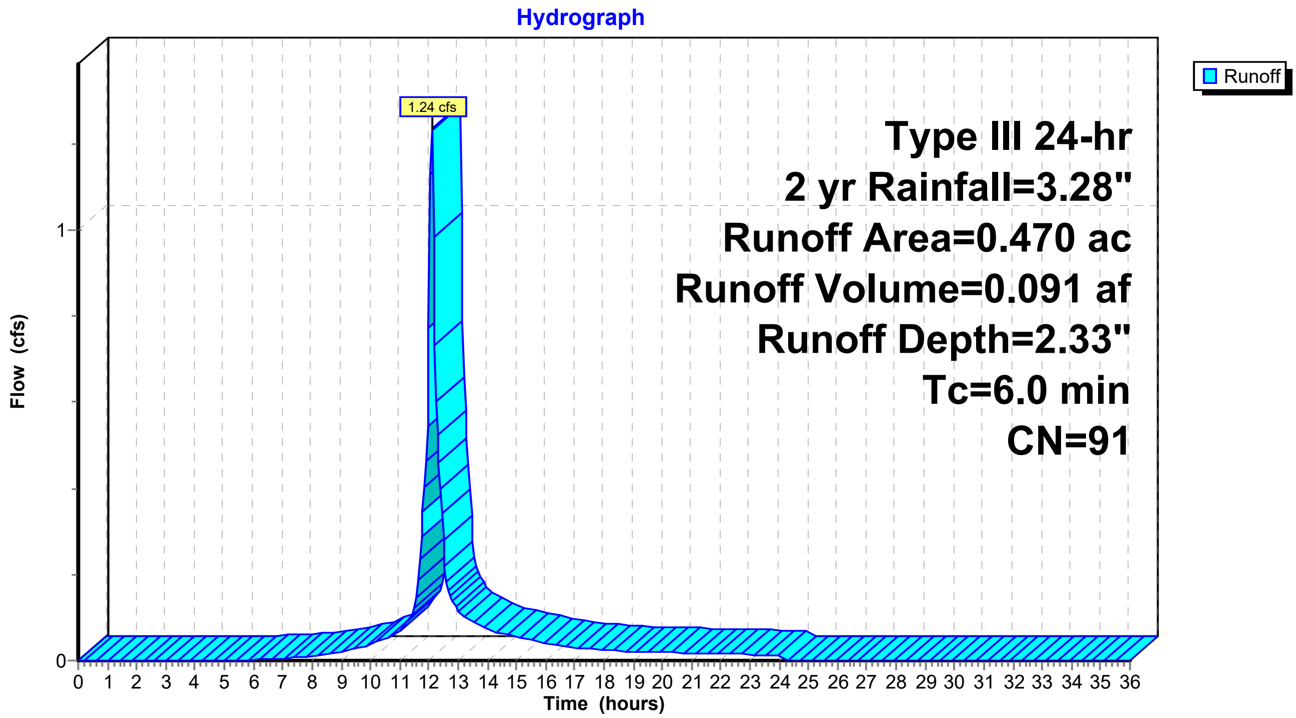
Runoff = 1.24 cfs @ 12.09 hrs, Volume= 0.091 af, Depth= 2.33"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.28"

Area (ac)	CN	Description
0.090	61	>75% Grass cover, Good, HSG B
0.380	98	Paved parking, HSG B
0.470	91	Weighted Average
0.090		19.15% Pervious Area
0.380		80.85% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-1A: PR-1A



Summary for Subcatchment PR-1B: PR-1B

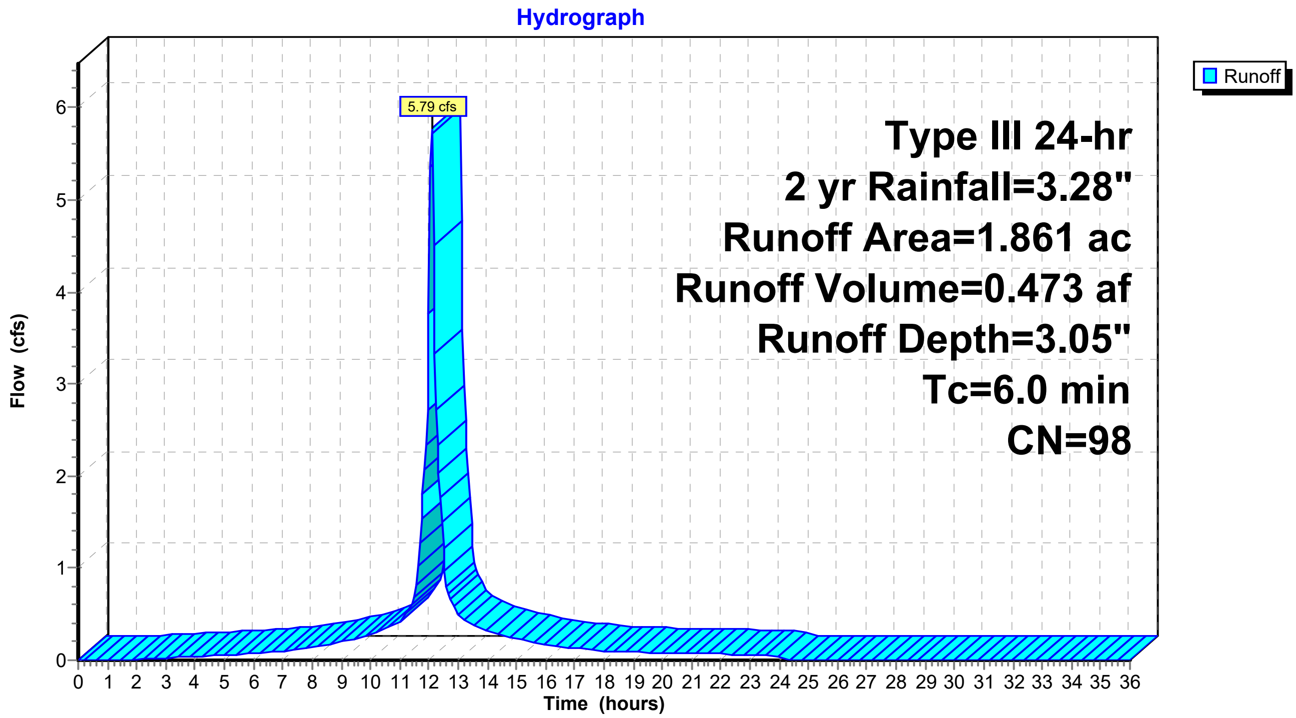
Runoff = 5.79 cfs @ 12.09 hrs, Volume= 0.473 af, Depth= 3.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.28"

Area (ac)	CN	Description
1.861	98	Roofs, HSG B
1.861		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-1B: PR-1B



Summary for Subcatchment PR-1C: PR-1C

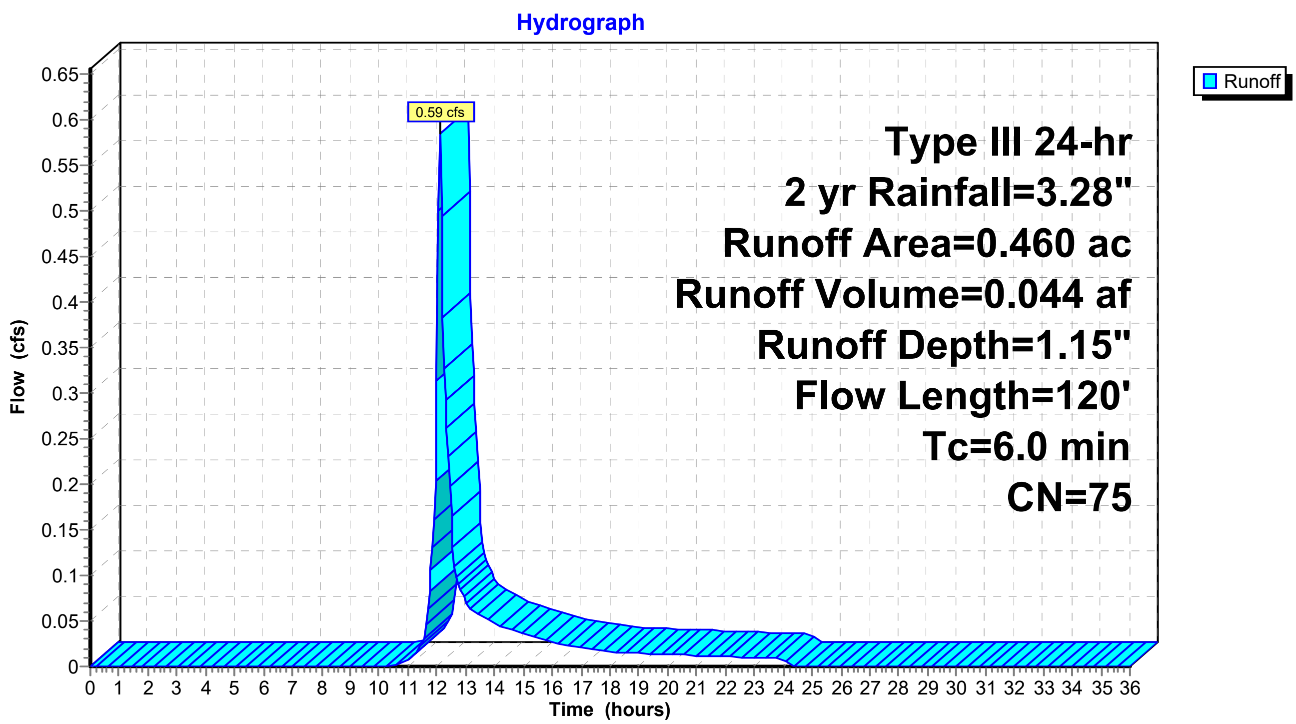
Runoff = 0.59 cfs @ 12.10 hrs, Volume= 0.044 af, Depth= 1.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.28"

Area (ac)	CN	Description
0.020	55	Woods, Good, HSG B
0.260	61	>75% Grass cover, Good, HSG B
0.180	98	Paved parking, HSG B
0.460	75	Weighted Average
0.280		60.87% Pervious Area
0.180		39.13% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	20	0.0700	0.09		**Sheet Flow, 20' SF** Woods: Light underbrush n= 0.400 P2= 3.20"
1.9	40	0.5000	0.35		**Sheet Flow, 30' SF** Grass: Dense n= 0.240 P2= 3.20"
0.1	12	0.0100	1.61		**Shallow Concentrated Flow, 12' SCF** Unpaved Kv= 16.1 fps
0.2	48	0.0400	4.06		**Shallow Concentrated Flow, 48' SCF** Paved Kv= 20.3 fps
5.8	120	Total, Increased to minimum Tc = 6.0 min			

Subcatchment PR-1C: PR-1C



Summary for Subcatchment PR-1D: PR-1D

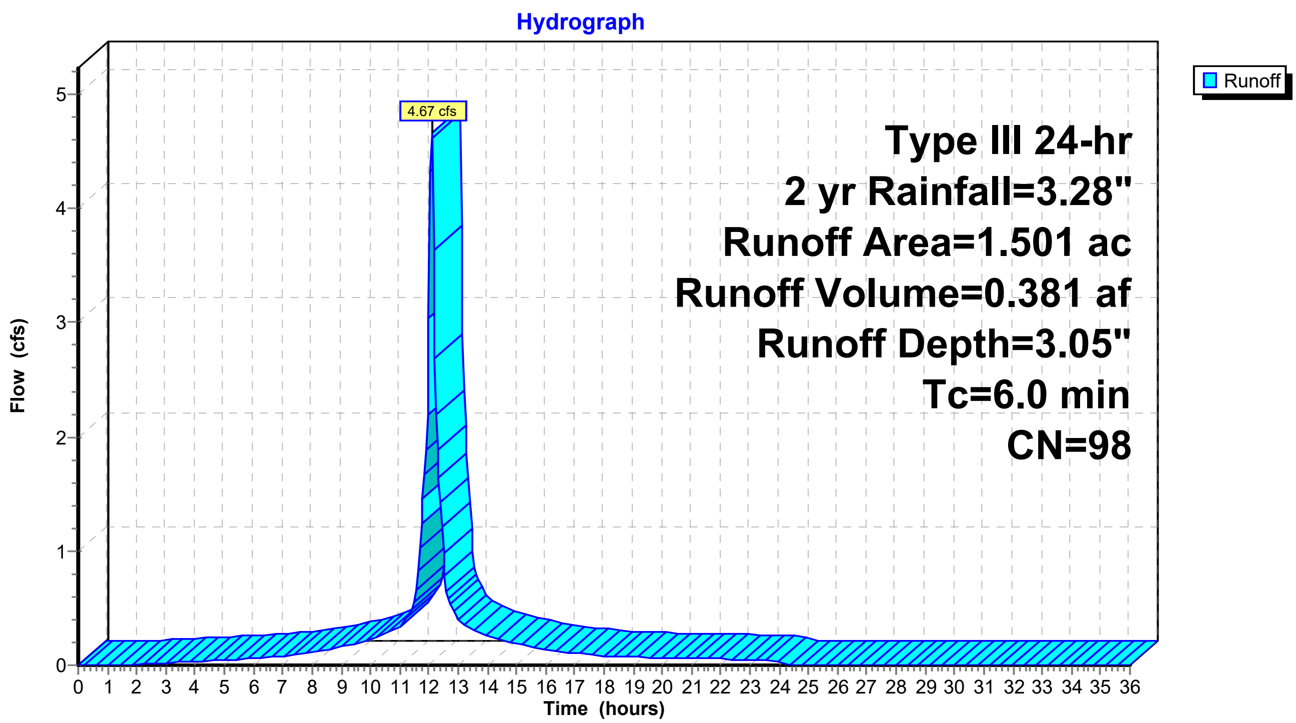
Runoff = 4.67 cfs @ 12.09 hrs, Volume= 0.381 af, Depth= 3.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.28"

Area (ac)	CN	Description
1.501	98	Roofs, HSG B
1.501		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-1D: PR-1D



Summary for Subcatchment PR-1E: PR-1E

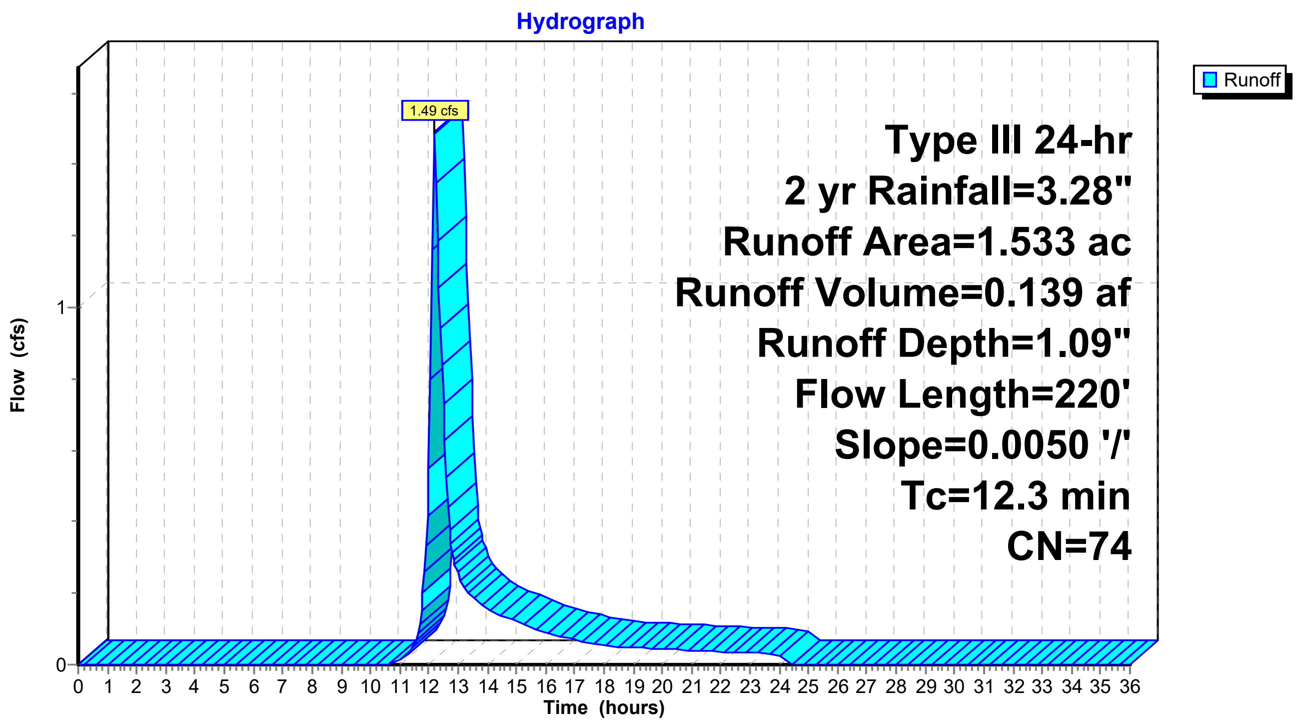
Runoff = 1.49 cfs @ 12.19 hrs, Volume= 0.139 af, Depth= 1.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.28"

Area (ac)	CN	Description
1.000	61	>75% Grass cover, Good, HSG B
0.533	98	Paved parking, HSG B
1.533	74	Weighted Average
1.000		65.23% Pervious Area
0.533		34.77% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.8	50	0.0050	0.09		**Sheet Flow, 50' SF** Grass: Short n= 0.150 P2= 3.20"
2.5	170	0.0050	1.14		**Shallow Concentrated Flow, 170' SCF** Unpaved Kv= 16.1 fps
12.3	220	Total			

Subcatchment PR-1E: PR-1E



Summary for Subcatchment PR-2: PR-2

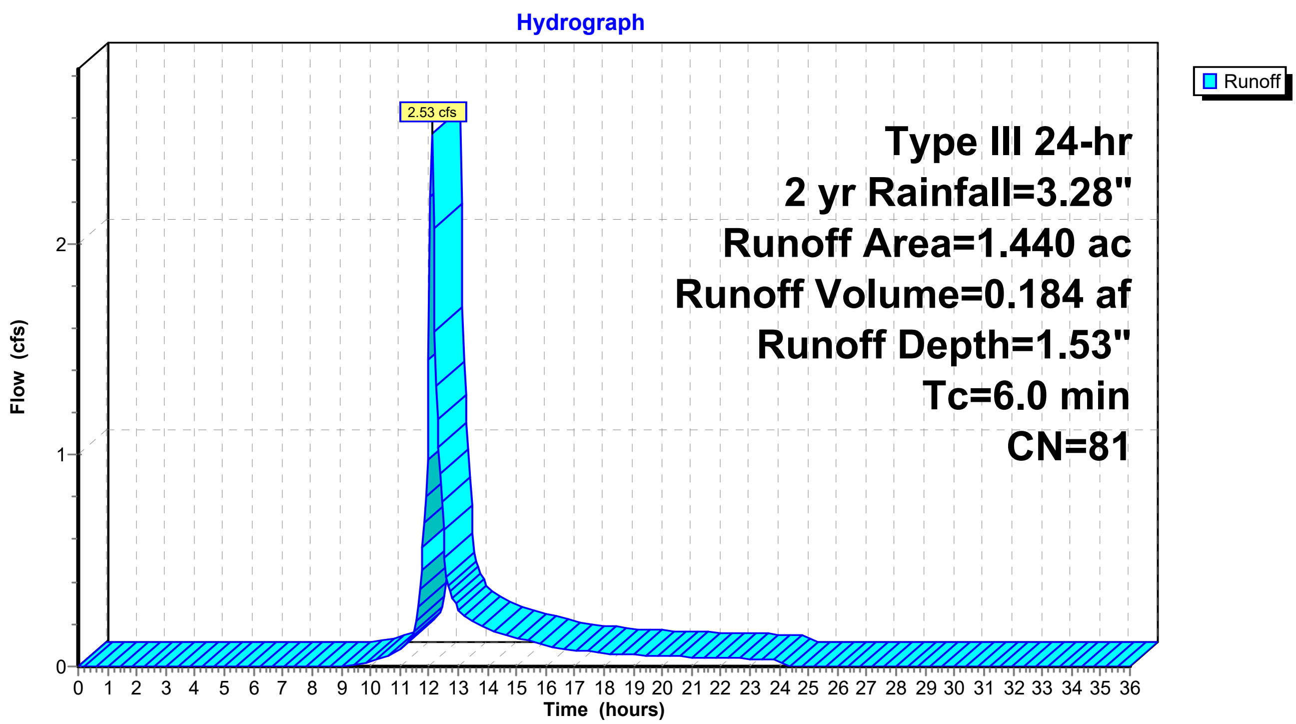
Runoff = 2.53 cfs @ 12.09 hrs, Volume= 0.184 af, Depth= 1.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.28"

Area (ac)	CN	Description
0.672	61	>75% Grass cover, Good, HSG B
0.768	98	Paved parking, HSG B
1.440	81	Weighted Average
0.672		46.67% Pervious Area
0.768		53.33% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-2: PR-2



Summary for Subcatchment PR-2B: PR-2B

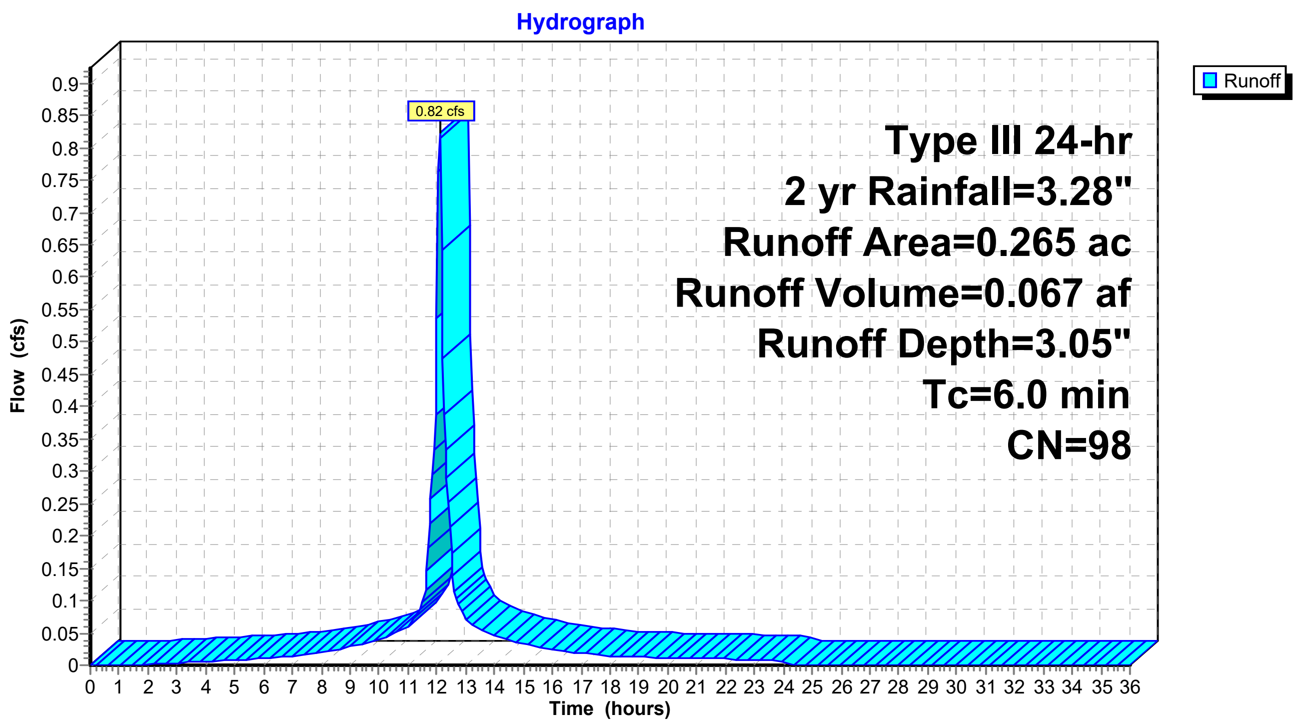
Runoff = 0.82 cfs @ 12.09 hrs, Volume= 0.067 af, Depth= 3.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.28"

Area (ac)	CN	Description
0.265	98	Roofs, HSG B
0.265		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-2B: PR-2B



Summary for Subcatchment PR-3A: PR-3A

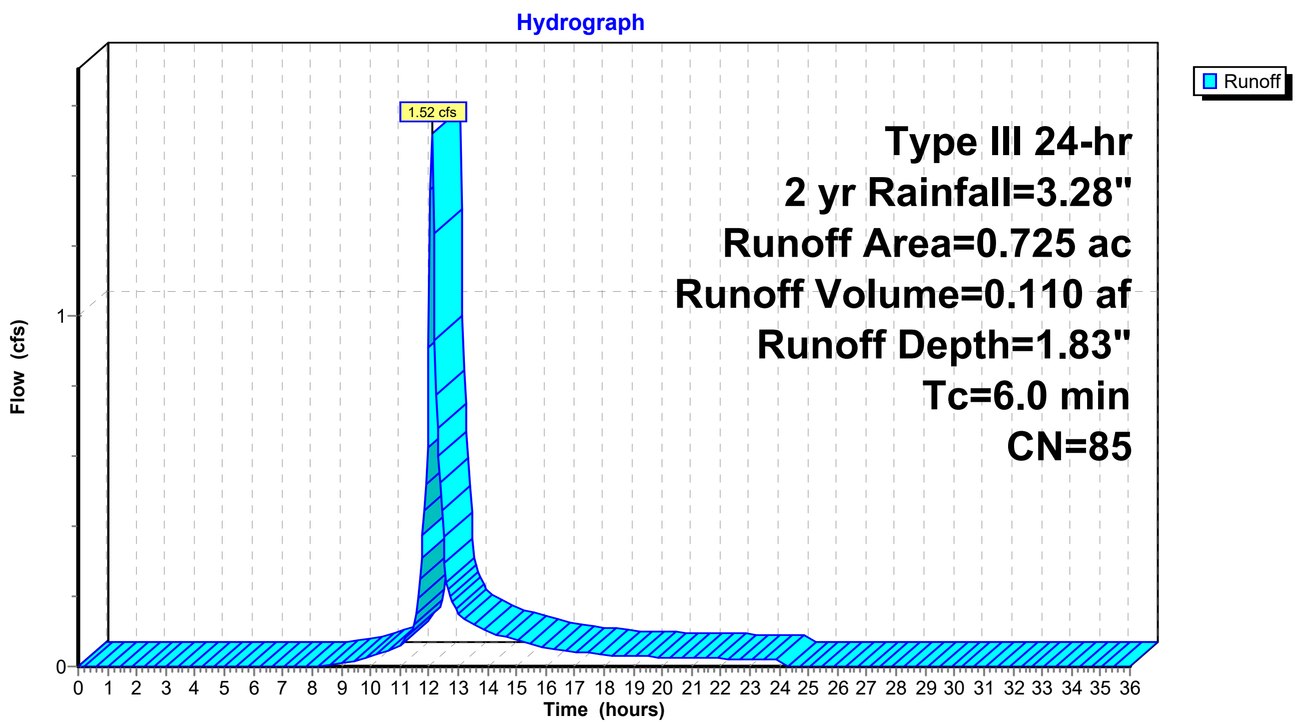
Runoff = 1.52 cfs @ 12.09 hrs, Volume= 0.110 af, Depth= 1.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.28"

Area (ac)	CN	Description
0.249	61	>75% Grass cover, Good, HSG B
0.476	98	Paved parking, HSG B
0.725	85	Weighted Average
0.249		34.34% Pervious Area
0.476		65.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-3A: PR-3A



Summary for Subcatchment PR-3B: PR-3B

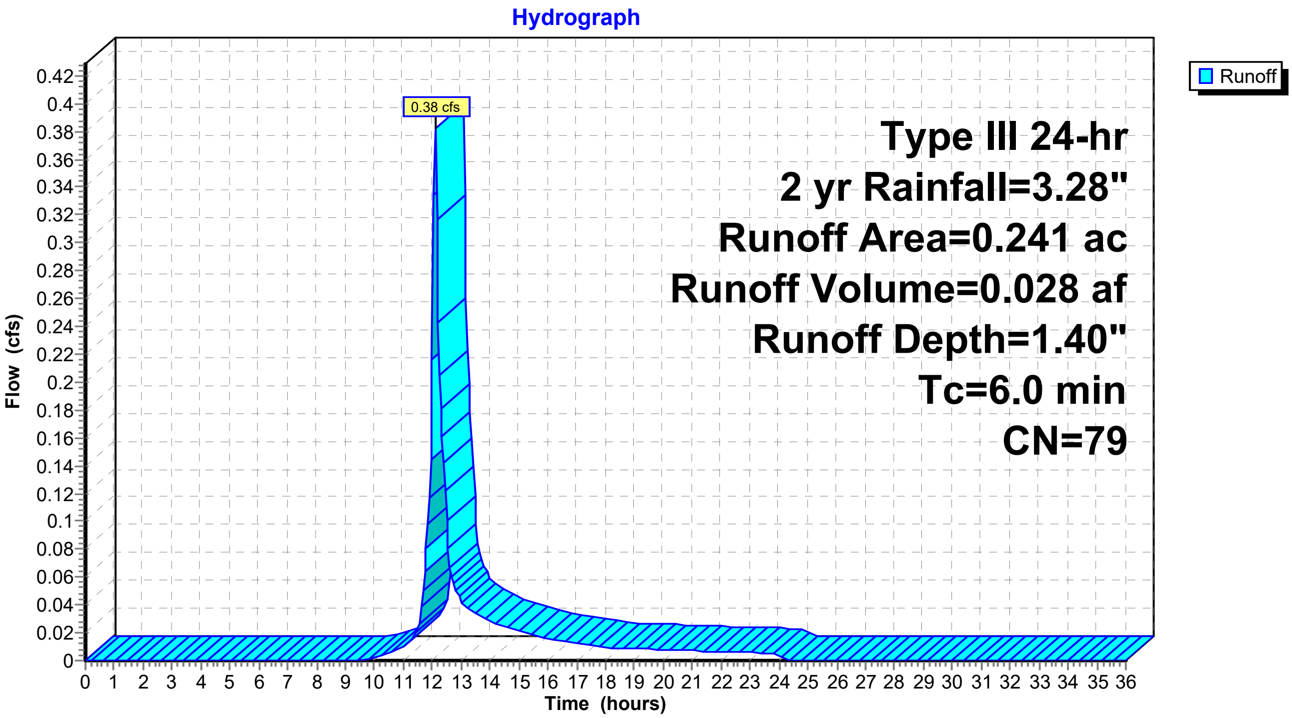
Runoff = 0.38 cfs @ 12.10 hrs, Volume= 0.028 af, Depth= 1.40"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.28"

Area (ac)	CN	Description
0.124	61	>75% Grass cover, Good, HSG B
0.117	98	Paved parking, HSG B
0.241	79	Weighted Average
0.124		51.45% Pervious Area
0.117		48.55% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-3B: PR-3B



Summary for Subcatchment PR-3C: PR-3C

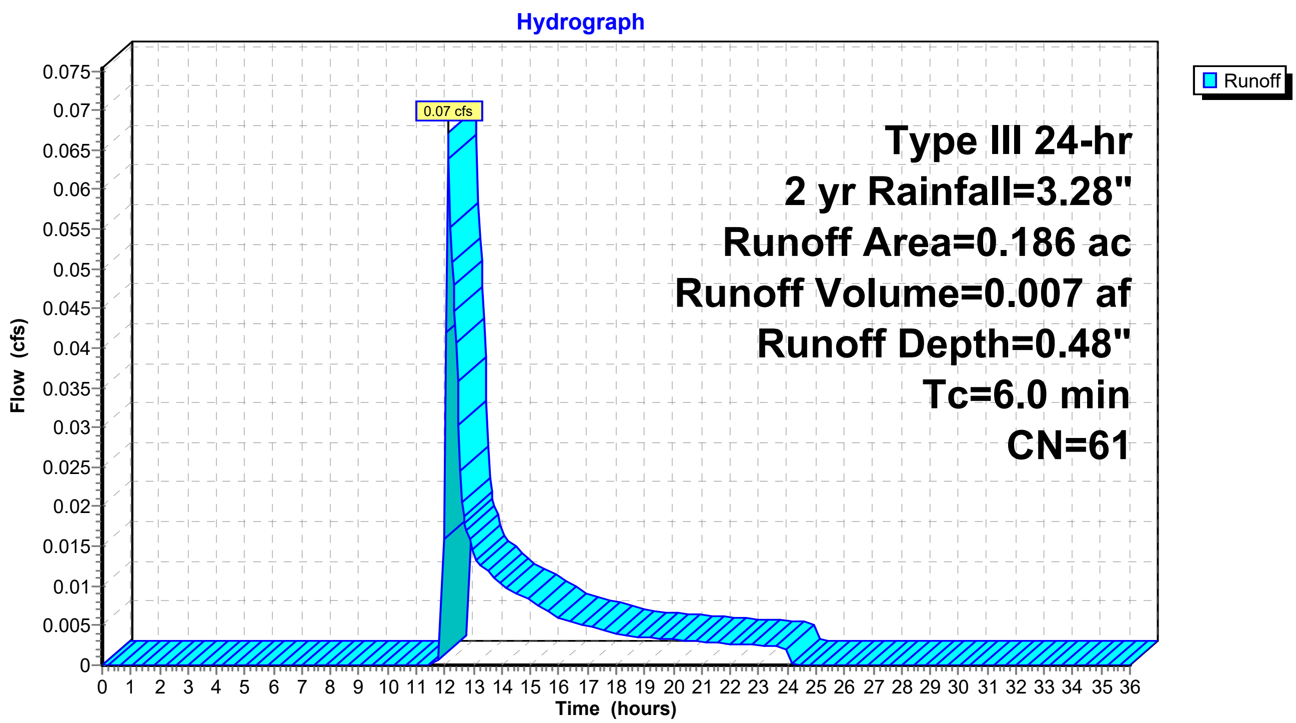
Runoff = 0.07 cfs @ 12.12 hrs, Volume= 0.007 af, Depth= 0.48"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.28"

Area (ac)	CN	Description
0.186	61	>75% Grass cover, Good, HSG B
0.186		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-3C: PR-3C



Summary for Subcatchment PR-4A: SB 01 A

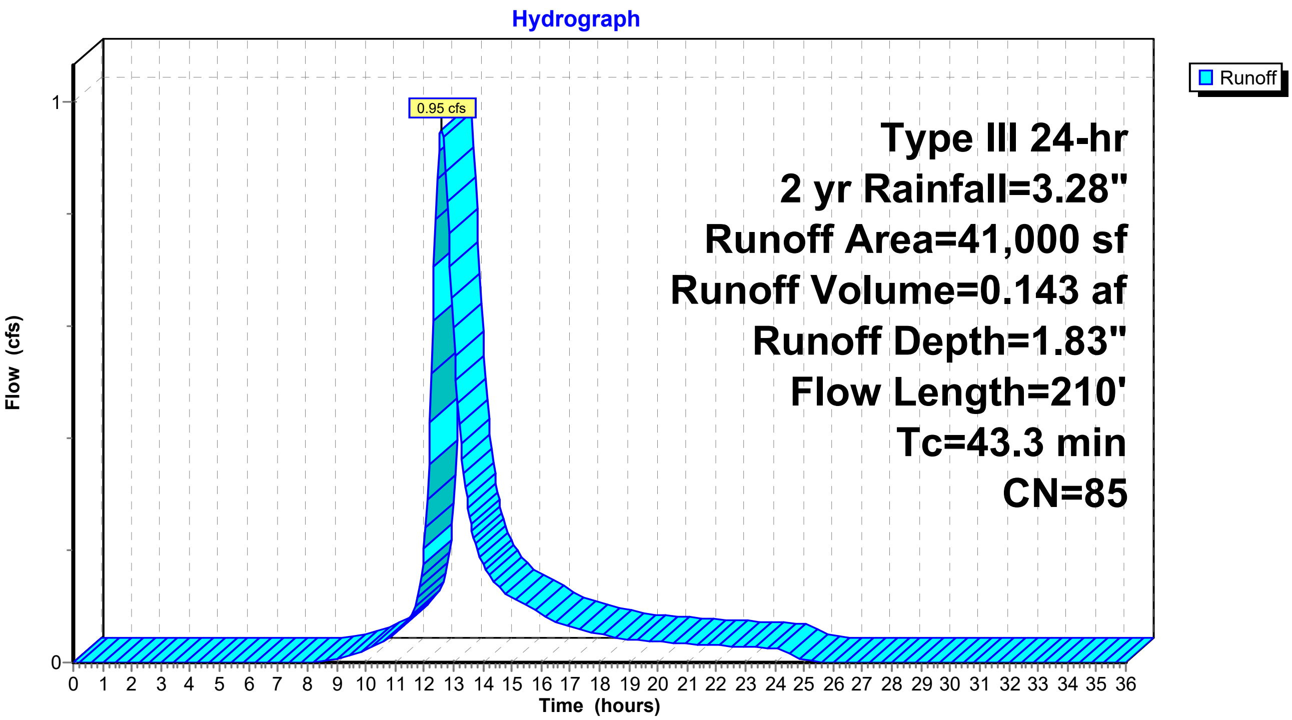
Runoff = 0.95 cfs @ 12.60 hrs, Volume= 0.143 af, Depth= 1.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.28"

	Area (sf)	CN	Description
*	41,000	85	SYNTHETIC TURF- PAD- LINER
	41,000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
39.6	110	0.0055	0.05		**Sheet Flow, Through Turf Section** Grass: Bermuda n= 0.410 P2= 3.20"
3.7	100	0.0001	0.45	0.16	**Pipe Channel, TRENCH DRAIN LEVEL** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010
43.3	210	Total			

Subcatchment PR-4A: SB 01 A



Summary for Subcatchment PR-4B: SB 11 A

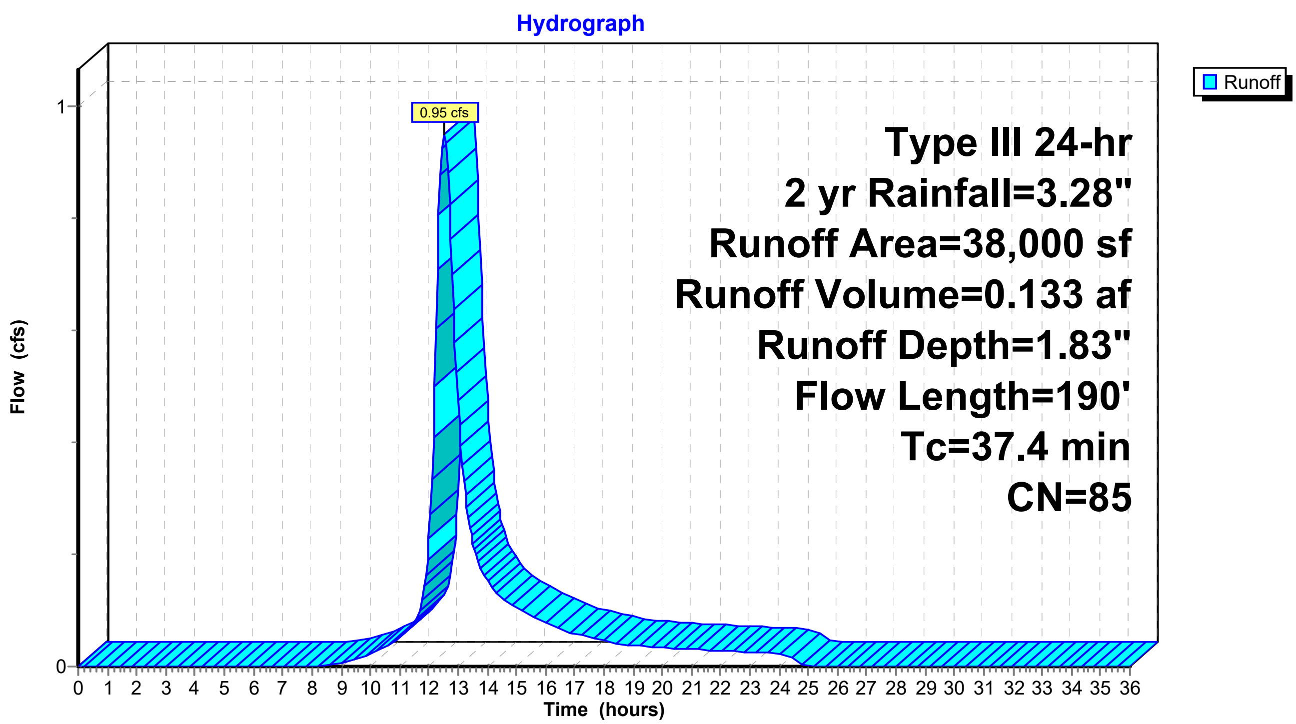
Runoff = 0.95 cfs @ 12.52 hrs, Volume= 0.133 af, Depth= 1.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.28"

	Area (sf)	CN	Description
*	38,000	85	SYNTHETIC TURF- PAD- LINER
	38,000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
33.7	90	0.0055	0.04		**Sheet Flow, Through Turf Section** Grass: Bermuda n= 0.410 P2= 3.20"
3.7	100	0.0001	0.45	0.16	**Pipe Channel, TRENCH DRAIN LEVEL** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010
37.4	190	Total			

Subcatchment PR-4B: SB 11 A



Summary for Subcatchment PR-4C: SB 00 DPW SLOPE

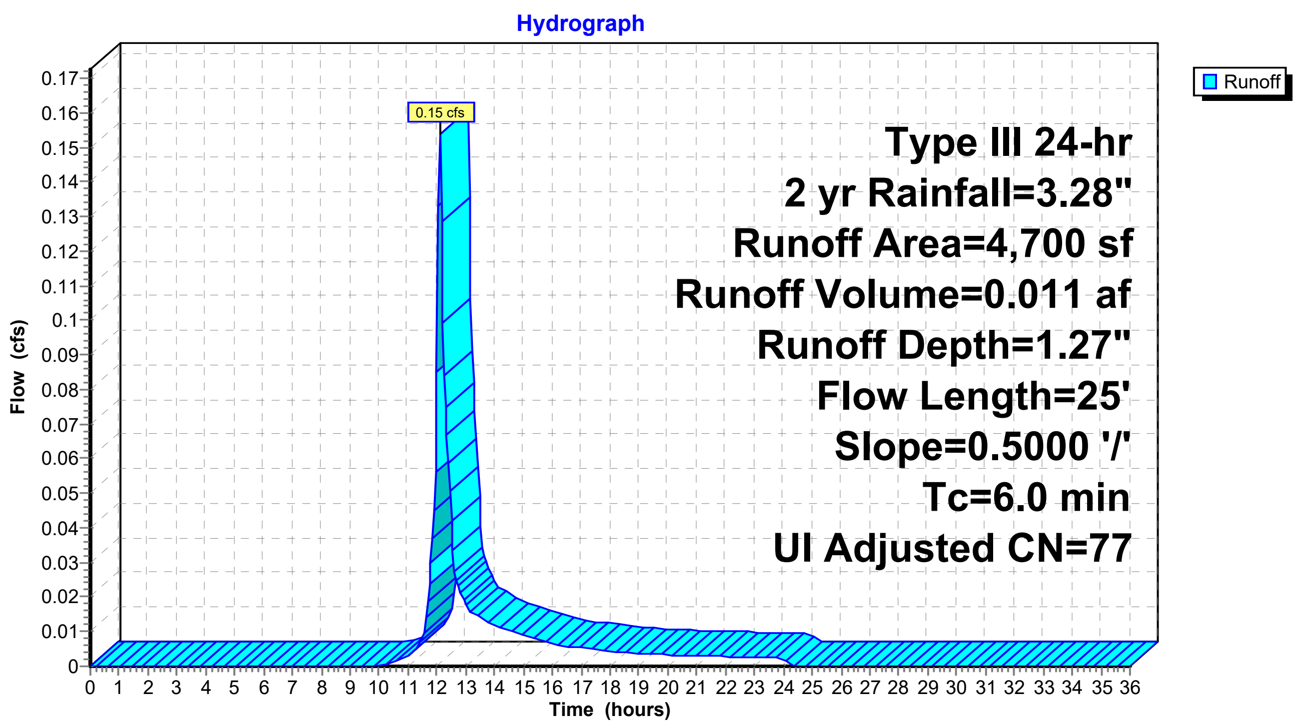
Runoff = 0.15 cfs @ 12.10 hrs, Volume= 0.011 af, Depth= 1.27"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.28"

Area (sf)	CN	Adj	Description
1,100	98		Unconnected pavement, HSG A
3,600	74		>75% Grass cover, Good, HSG C
4,700	80	77	Weighted Average, UI Adjusted
3,600			76.60% Pervious Area
1,100			23.40% Impervious Area
1,100			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.3	25	0.5000	0.32		**Sheet Flow, SLOPING LAND** Grass: Dense n= 0.240 P2= 3.20"
1.3	25	Total, Increased to minimum Tc = 6.0 min			

Subcatchment PR-4C: SB 00 DPW SLOPE



Summary for Subcatchment PR-5A: BB 01 A

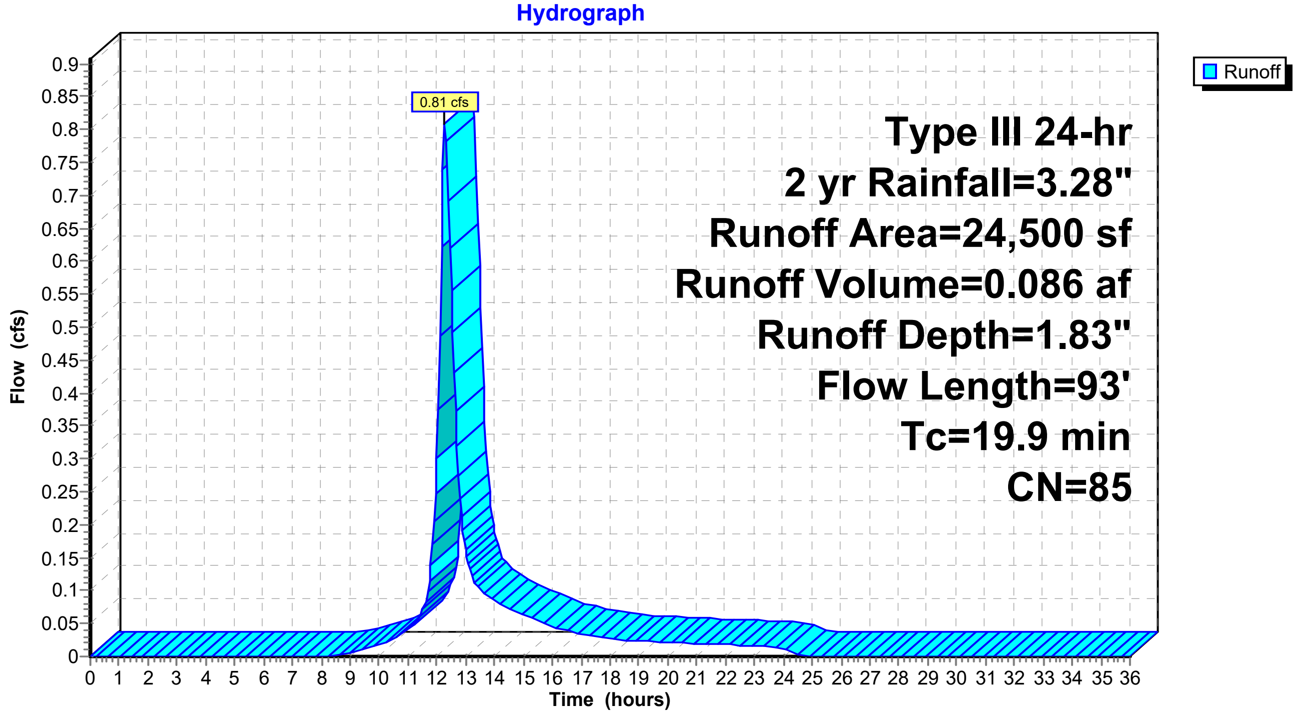
Runoff = 0.81 cfs @ 12.28 hrs, Volume= 0.086 af, Depth= 1.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.28"

	Area (sf)	CN	Description
*	24,500	85	SYNTHETIC TURF- PAD- LINER
	24,500		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.2	46	0.0067	0.04		**Sheet Flow, Through Turf Section** Grass: Bermuda n= 0.410 P2= 3.20"
1.7	47	0.0001	0.45	0.16	**Pipe Channel, TRENCH DRAIN LEVEL** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010
19.9	93	Total			

Subcatchment PR-5A: BB 01 A



Summary for Subcatchment PR-5B: BB 11 A

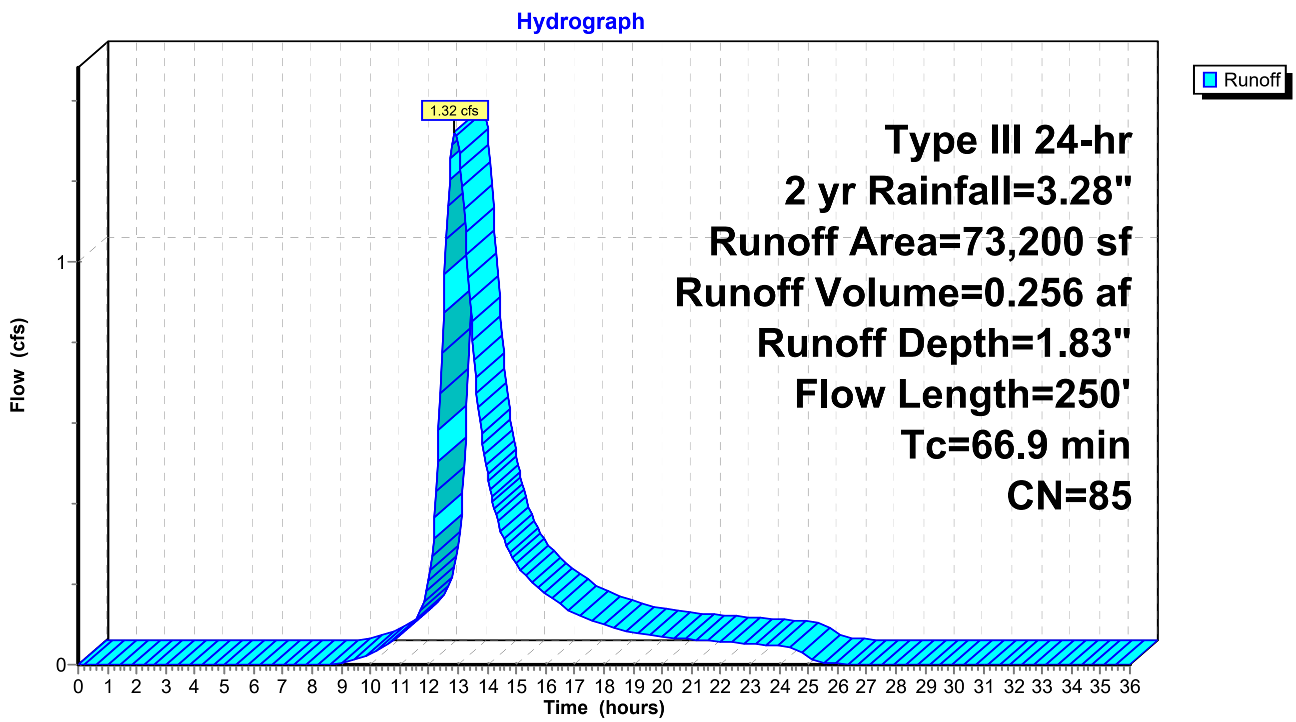
Runoff = 1.32 cfs @ 12.90 hrs, Volume= 0.256 af, Depth= 1.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.28"

	Area (sf)	CN	Description
*	73,200	85	SYNTHETIC TURF- PAD- LINER
	73,200		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.1	53	0.0055	0.04		**Sheet Flow, Through Turf Section** Grass: Bermuda n= 0.410 P2= 3.20"
43.1	150	0.0083	0.06		**Sheet Flow, SYNTHETIC TURF** Grass: Bermuda n= 0.410 P2= 3.20"
1.7	47	0.0001	0.45	0.16	**Pipe Channel, TRENCH DRAIN LEVEL** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010
66.9	250	Total			

Subcatchment PR-5B: BB 11 A



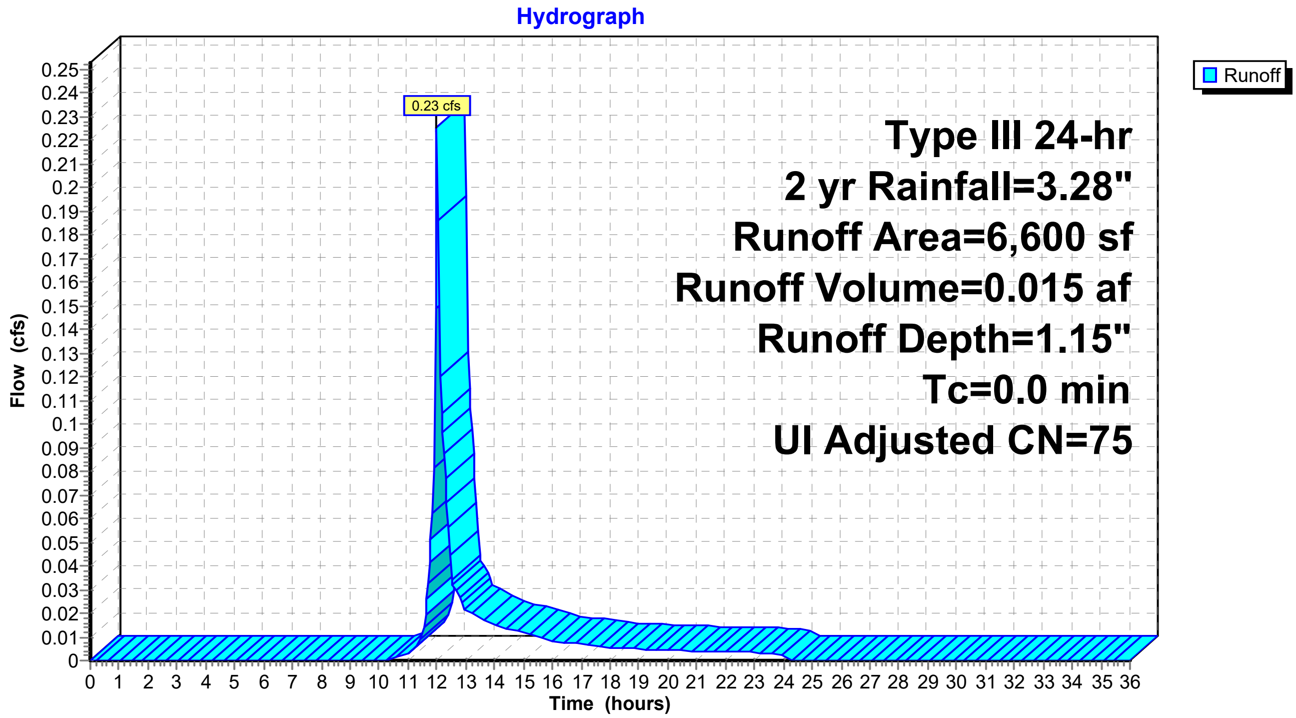
Summary for Subcatchment PR-5C: SLOPE

Runoff = 0.23 cfs @ 12.01 hrs, Volume= 0.015 af, Depth= 1.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.28"

Area (sf)	CN	Adj	Description
600	98		Unconnected roofs, HSG C
6,000	74		>75% Grass cover, Good, HSG C
6,600	76	75	Weighted Average, UI Adjusted
6,000			90.91% Pervious Area
600			9.09% Impervious Area
600			100.00% Unconnected

Subcatchment PR-5C: SLOPE



Summary for Pond 2P: rain garden#2 cascading

Inflow Area =	0.966 ac,	61.39% Impervious,	Inflow Depth > 1.67"	for 2 yr event
Inflow =	1.90 cfs @	12.10 hrs, Volume=	0.134 af	
Outflow =	1.61 cfs @	12.17 hrs, Volume=	0.118 af,	Atten= 15%, Lag= 4.5 min
Primary =	0.03 cfs @	12.15 hrs, Volume=	0.045 af	
Secondary =	1.59 cfs @	12.17 hrs, Volume=	0.072 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 54.58' @ 12.15 hrs Surf.Area= 1,062 sf Storage= 1,285 cf
Flood Elev= 55.00' Surf.Area= 1,326 sf Storage= 1,784 cf

Plug-Flow detention time= 218.3 min calculated for 0.118 af (88% of inflow)
Center-of-Mass det. time= 127.7 min (1,032.2 - 904.5)

Volume	Invert	Avail.Storage	Storage Description
#1	51.00'	1,557 cf	**Rain Garden Envelope (Prismatic)** Listed below (Recalc) 2,357 cf Overall - 800 cf Embedded = 1,557 cf
#2	51.00'	80 cf	**crush stone (Prismatic)** Listed below (Recalc) Inside #1 200 cf Overall x 40.0% Voids
#3	51.50'	133 cf	**Bio Media (Prismatic)** Listed below (Recalc) Inside #1 532 cf Overall x 25.0% Voids
#4	52.83'	14 cf	**Mulch (Prismatic)** Listed below (Recalc) Inside #1 68 cf Overall x 20.0% Voids
		1,784 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
51.00	400	0	0
53.00	400	800	800
54.00	694	547	1,347
55.00	1,326	1,010	2,357

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
51.00	400	0	0
51.50	400	200	200

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
51.50	400	0	0
52.83	400	532	532

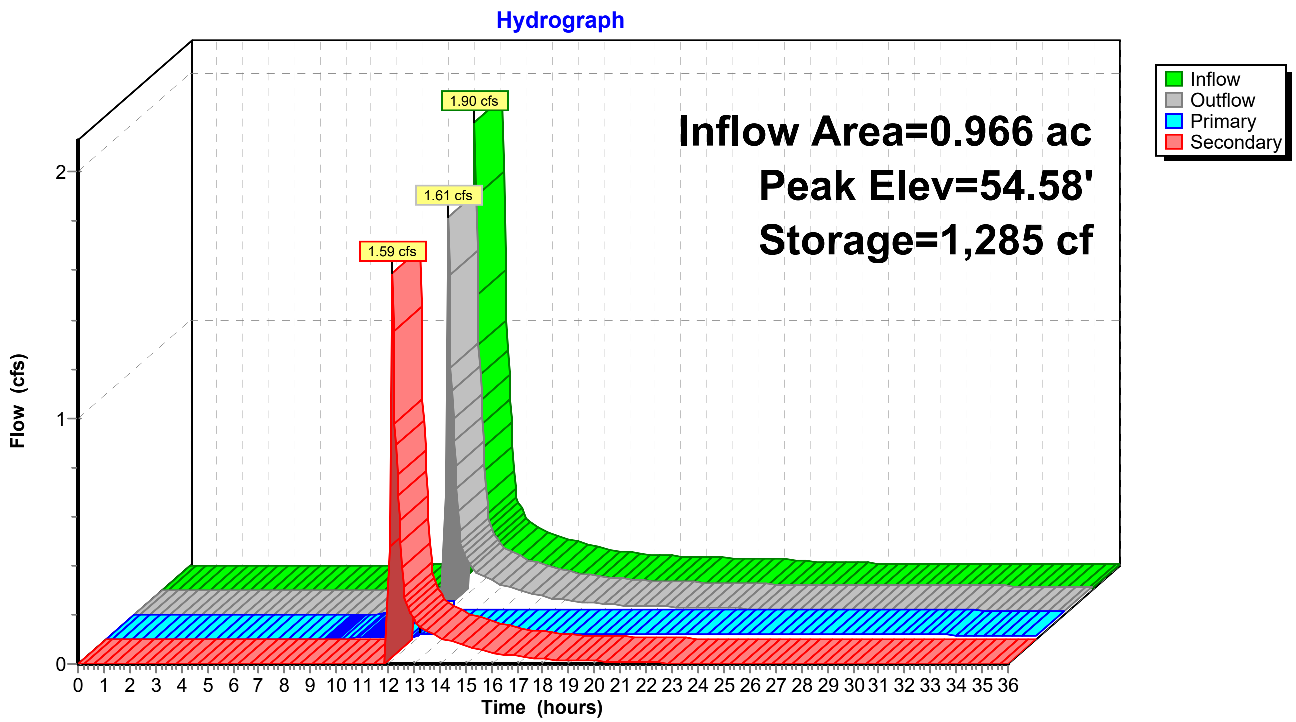
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
52.83	400	0	0
53.00	400	68	68

Device	Routing	Invert	Outlet Devices
#1	Device 3	51.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Secondary	54.50'	**25.0' long x 3.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32
#3	Primary	51.00'	**12.0" Round Culvert** L= 25.0' Ke= 0.500 Inlet / Outlet Invert= 51.00' / 50.88' S= 0.0048 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf

Primary OutFlow Max=0.03 cfs @ 12.15 hrs HW=54.58' TW=46.87' (Dynamic Tailwater)
└─**3=Culvert** (Passes 0.03 cfs of 6.64 cfs potential flow)
  └─**1=Exfiltration** (Exfiltration Controls 0.03 cfs)

Secondary OutFlow Max=1.40 cfs @ 12.17 hrs HW=54.58' TW=47.44' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir** (Weir Controls 1.40 cfs @ 0.69 fps)

Pond 2P: rain garden#2 cascading



Summary for Pond 3P: rain garden#3 cascading

Inflow Area = 1.152 ac, 51.48% Impervious, Inflow Depth > 1.30" for 2 yr event
Inflow = 1.68 cfs @ 12.17 hrs, Volume= 0.125 af
Outflow = 0.14 cfs @ 14.02 hrs, Volume= 0.084 af, Atten= 92%, Lag= 111.0 min
Primary = 0.14 cfs @ 14.02 hrs, Volume= 0.084 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 50.02' @ 14.02 hrs Surf.Area= 1,386 sf Storage= 2,310 cf
Flood Elev= 50.00' Surf.Area= 1,373 sf Storage= 2,283 cf

Plug-Flow detention time= 497.6 min calculated for 0.084 af (67% of inflow)
Center-of-Mass det. time= 276.1 min (1,301.1 - 1,025.0)

Volume	Invert	Avail.Storage	Storage Description
#1	46.00'	2,710 cf	**Rain Garden Envelope (Prismatic)** Listed below (Recalc) 3,911 cf Overall - 1,200 cf Embedded = 2,710 cf
#2	46.00'	120 cf	**crush stone (Prismatic)** Listed below (Recalc) Inside #1 300 cf Overall x 40.0% Voids
#3	46.50'	199 cf	**Bio Media (Prismatic)** Listed below (Recalc) Inside #1 798 cf Overall x 25.0% Voids
#4	47.83'	20 cf	**Mulch (Prismatic)** Listed below (Recalc) Inside #1 102 cf Overall x 20.0% Voids
		3,050 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
46.00	600	0	0
48.00	600	1,200	1,200
49.00	957	779	1,979
50.00	1,373	1,165	3,144
50.50	1,695	767	3,911

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
46.00	600	0	0
46.50	600	300	300

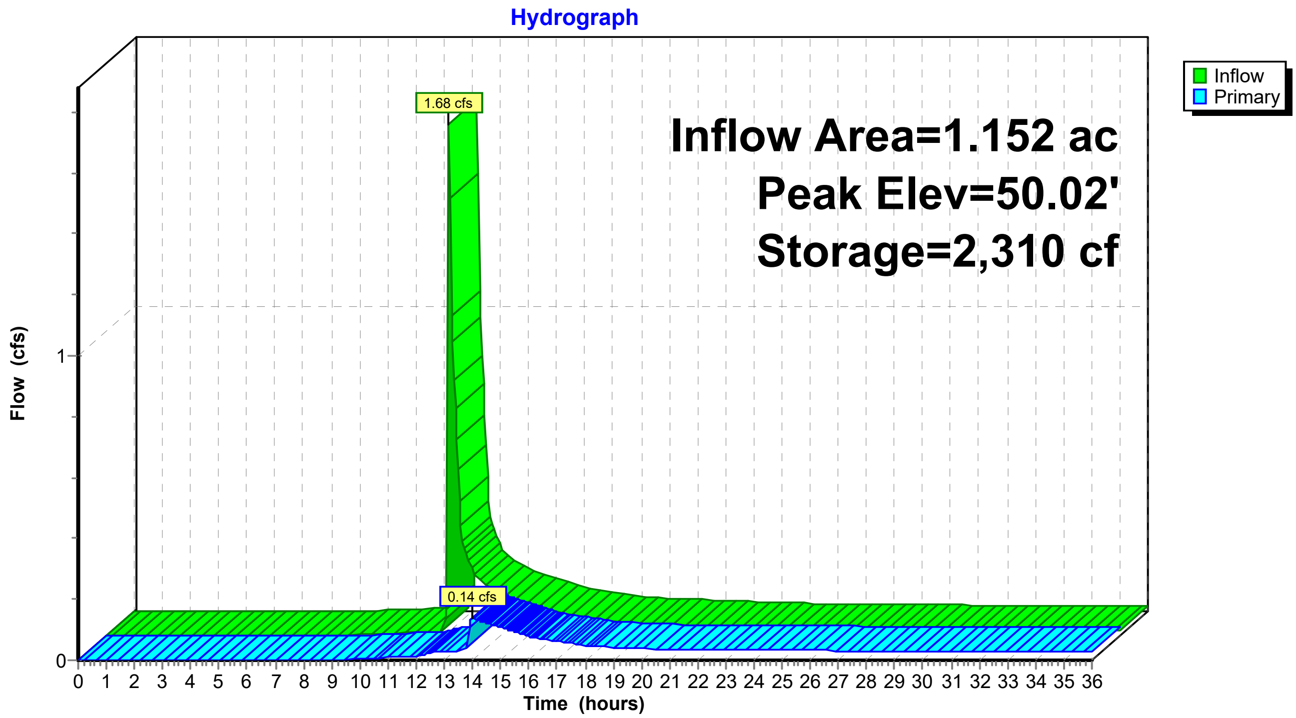
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
46.50	600	0	0
47.83	600	798	798

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
47.83	600	0	0
48.00	600	102	102

Device	Routing	Invert	Outlet Devices
#1	Device 3	46.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Device 3	50.00'	**24.0" x 48.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Primary	46.00'	**15.0" Round Culvert** L= 26.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 46.00' / 45.87' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf

Primary OutFlow Max=0.14 cfs @ 14.02 hrs HW=50.02' TW=0.00' (Dynamic Tailwater)
3=Culvert (Passes 0.14 cfs of 8.59 cfs potential flow)
1=Exfiltration (Exfiltration Controls 0.03 cfs)
2=Orifice/Grate (Weir Controls 0.11 cfs @ 0.46 fps)

Pond 3P: rain garden#3 cascading



Summary for Pond 4P: UGS-1

Inflow Area = 1.705 ac, 60.59% Impervious, Inflow Depth = 1.77" for 2 yr event
Inflow = 3.35 cfs @ 12.09 hrs, Volume= 0.251 af
Outflow = 1.36 cfs @ 12.35 hrs, Volume= 0.215 af, Atten= 59%, Lag= 15.4 min
Discarded = 0.04 cfs @ 10.25 hrs, Volume= 0.094 af
Primary = 1.32 cfs @ 12.35 hrs, Volume= 0.120 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 43.11' @ 12.35 hrs Surf.Area= 1,672 sf Storage= 4,001 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 227.2 min (1,043.4 - 816.2)

Volume	Invert	Avail.Storage	Storage Description
#1A	39.50'	2,099 cf	**29.92'W x 55.89'L x 5.50'H Field A** 9,196 cf Overall - 3,198 cf Embedded = 5,998 cf x 35.0% Voids
#2A	40.25'	3,198 cf	**ADS_StormTech MC-3500 d +Cap** x 28 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap 28 Chambers in 4 Rows Cap Storage= +14.9 cf x 2 x 4 rows = 119.2 cf
		5,297 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	39.25'	**24.0" Round Culvert** L= 50.0' Ke= 0.500 Inlet / Outlet Invert= 39.25' / 38.75' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf
#2	Device 1	43.67'	**5.0' long x 4.00' rise Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Discarded	39.50'	**1.020 in/hr Exfiltration over Surface area**
#4	Device 1	42.42'	**9.0" Vert. Orifice/Grate** X 3 rows with 6.0" cc spacing C= 0.600

Discarded OutFlow Max=0.04 cfs @ 10.25 hrs HW=39.59' (Free Discharge)
└─**3=Exfiltration** (Exfiltration Controls 0.04 cfs)

Primary OutFlow Max=1.32 cfs @ 12.35 hrs HW=43.11' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Passes 1.32 cfs of 25.56 cfs potential flow)
  ├─**2=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)
  └─**4=Orifice/Grate** (Orifice Controls 1.32 cfs @ 2.59 fps)

Pond 4P: UGS-1 - Chamber Wizard Field A

Chamber Model = ADS_StormTechMC-3500 d +Cap (ADS StormTech®MC-3500 d rev 03/14 with Cap volume)
Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf
Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap
Cap Storage= +14.9 cf x 2 x 4 rows = 119.2 cf

77.0" Wide + 9.0" Spacing = 86.0" C-C Row Spacing

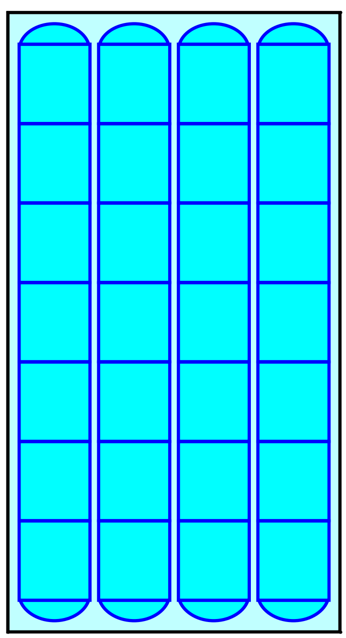
7 Chambers/Row x 7.17' Long +1.85' Cap Length x 2 = 53.89' Row Length +12.0" End Stone x 2 = 55.89' Base Length
4 Rows x 77.0" Wide + 9.0" Spacing x 3 + 12.0" Side Stone x 2 = 29.92' Base Width
9.0" Base + 45.0" Chamber Height + 12.0" Cover = 5.50' Field Height

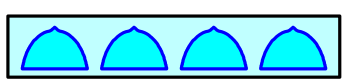
28 Chambers x 110.0 cf + 14.9 cf Cap Volume x 2 x 4 Rows = 3,197.9 cf Chamber Storage

9,196.2 cf Field - 3,197.9 cf Chambers = 5,998.4 cf Stone x 35.0% Voids = 2,099.4 cf Stone Storage

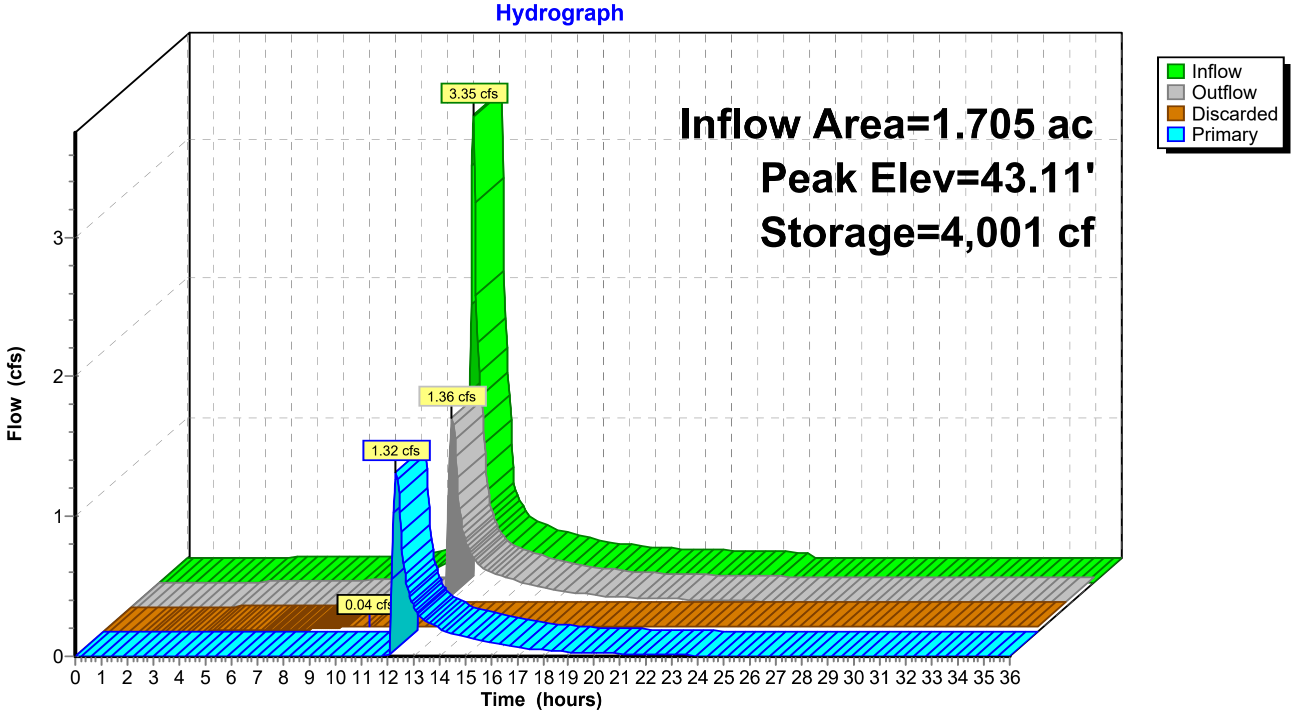
Chamber Storage + Stone Storage = 5,297.3 cf = 0.122 af
Overall Storage Efficiency = 57.6%
Overall System Size = 55.89' x 29.92' x 5.50'

28 Chambers
340.6 cy Field
222.2 cy Stone





Pond 4P: UGS-1


Hydrograph
3.35 cfs
1.36 cfs
1.32 cfs
0.04 cfs
Inflow Area=1.705 ac
Peak Elev=43.11'
Storage=4,001 cf
Inflow
Outflow
Discarded
Primary
Flow (cfs)
0
1
2
3
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36
Time (hours)

Summary for Pond 5P: rain garden#1 cascading

Inflow Area = 0.725 ac, 65.66% Impervious, Inflow Depth = 1.83" for 2 yr event
Inflow = 1.52 cfs @ 12.09 hrs, Volume= 0.110 af
Outflow = 1.52 cfs @ 12.10 hrs, Volume= 0.106 af, Atten= 0%, Lag= 0.3 min
Primary = 0.01 cfs @ 12.10 hrs, Volume= 0.022 af
Secondary = 1.51 cfs @ 12.10 hrs, Volume= 0.084 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 62.08' @ 12.10 hrs Surf.Area= 516 sf Storage= 594 cf
Flood Elev= 63.00' Surf.Area= 660 sf Storage= 1,132 cf

Plug-Flow detention time= 115.3 min calculated for 0.106 af (96% of inflow)
Center-of-Mass det. time= 95.3 min (920.3 - 825.0)

Volume	Invert	Avail.Storage	Storage Description
#1	58.50'	1,048 cf	**Rain Garden Envelope (Prismatic)**Listed below (Recalc) 1,348 cf Overall - 300 cf Embedded = 1,048 cf
#2	58.50'	30 cf	**crush stone (Prismatic)**Listed below (Recalc) Inside #1 75 cf Overall x 40.0% Voids
#3	59.00'	50 cf	**Bio Media (Prismatic)**Listed below (Recalc) Inside #1 199 cf Overall x 25.0% Voids
#4	60.33'	5 cf	**Mulch (Prismatic)**Listed below (Recalc) Inside #1 26 cf Overall x 20.0% Voids
		1,132 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
58.50	150	0	0
60.50	150	300	300
61.00	236	97	397
62.00	503	370	766
63.00	660	582	1,348

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
58.50	150	0	0
59.00	150	75	75

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
59.00	150	0	0
60.33	150	199	199

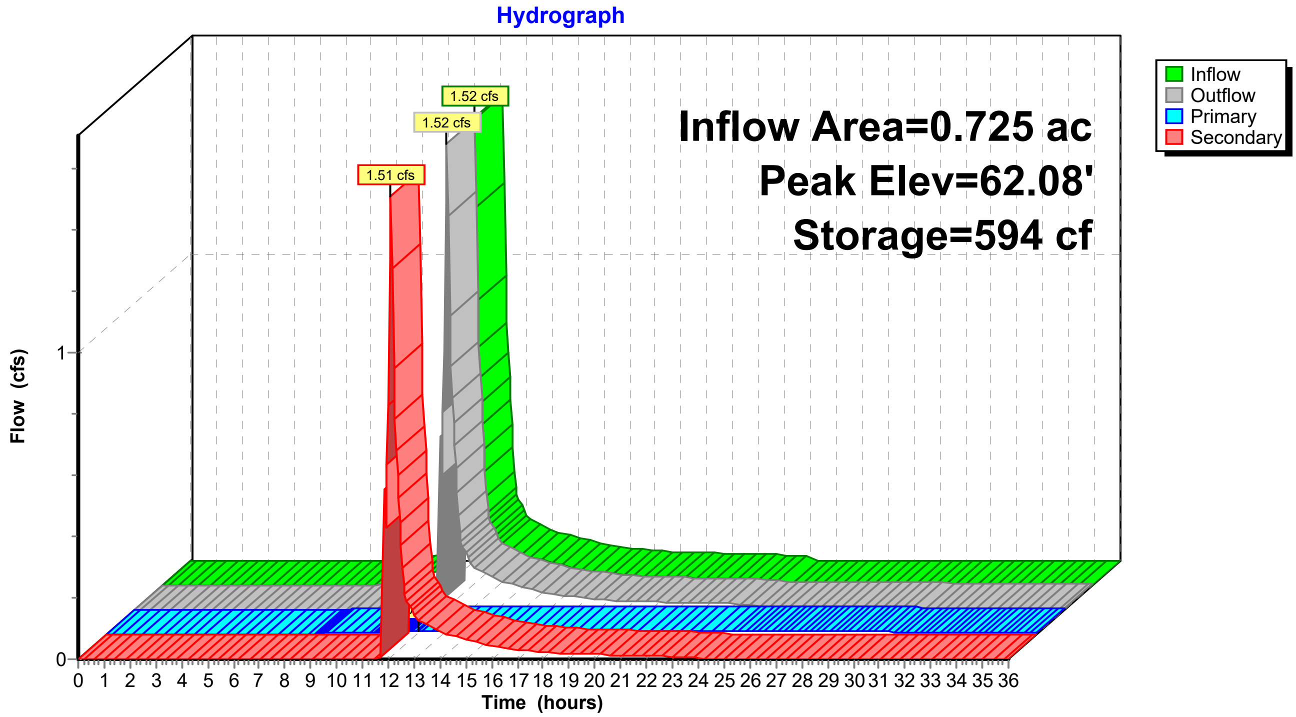
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
60.33	150	0	0
60.50	150	26	26

Device	Routing	Invert	Outlet Devices
#1	Device 3	58.50'	**1.020 in/hr Exfiltration over Surface area**
#2	Secondary	62.00'	**25.0' long x 3.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32
#3	Primary	58.50'	**8.0" Round Culvert** L= 20.0' Ke= 0.500 Inlet / Outlet Invert= 58.50' / 58.40' S= 0.0050 '/' Cc= 0.900 n= 0.012, Flow Area= 0.35 sf

Primary OutFlow Max=0.01 cfs @ 12.10 hrs HW=62.08' TW=54.39' (Dynamic Tailwater)
└─**3=Culvert** (Passes 0.01 cfs of 3.03 cfs potential flow)
  └─**1=Exfiltration** (Exfiltration Controls 0.01 cfs)

Secondary OutFlow Max=1.50 cfs @ 12.10 hrs HW=62.08' TW=54.39' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir** (Weir Controls 1.50 cfs @ 0.71 fps)

Pond 5P: rain garden#1 cascading



Summary for Pond BB 01 B: BB 01 B

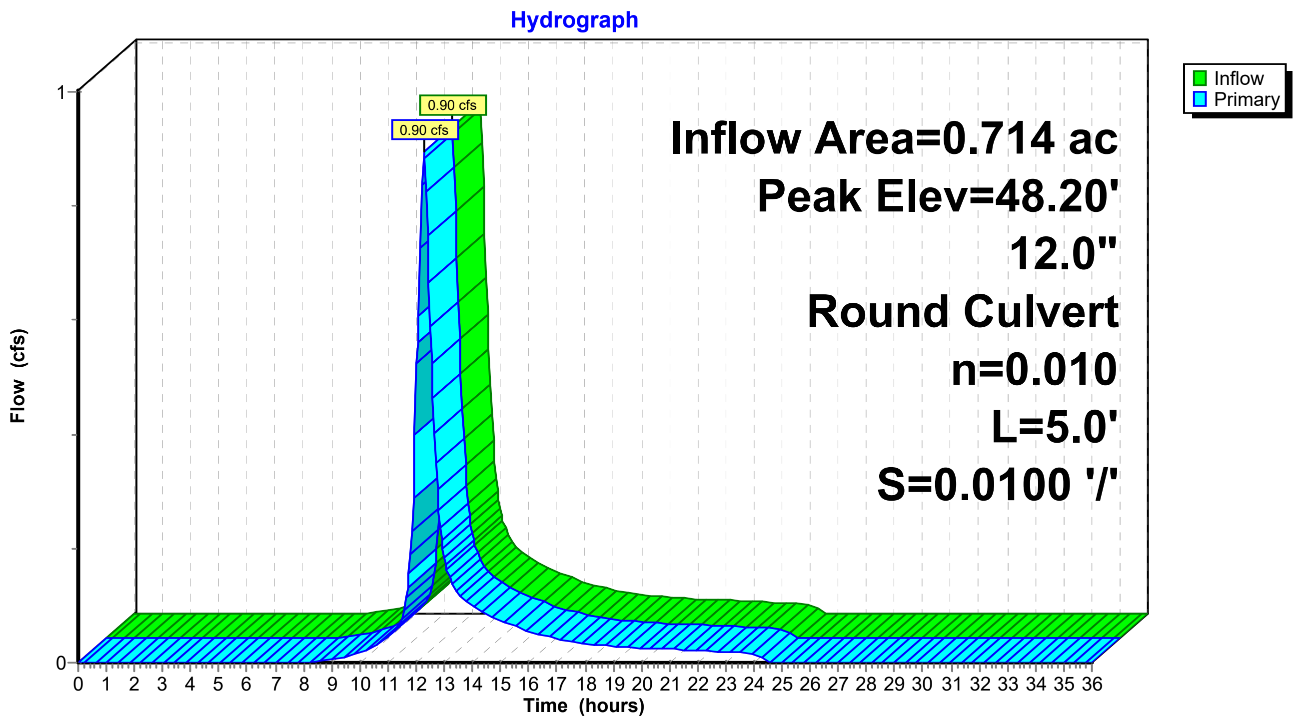
Inflow Area = 0.714 ac, 1.93% Impervious, Inflow Depth = 1.68" for 2 yr event
Inflow = 0.90 cfs @ 12.27 hrs, Volume= 0.100 af
Outflow = 0.90 cfs @ 12.27 hrs, Volume= 0.100 af, Atten= 0%, Lag= 0.0 min
Primary = 0.90 cfs @ 12.27 hrs, Volume= 0.100 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 48.20' @ 12.27 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	47.63'	**12.0" Round Culvert** L= 5.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 47.63' / 47.58' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=0.89 cfs @ 12.27 hrs HW=48.20' TW=46.58' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 0.89 cfs @ 2.78 fps)

Pond BB 01 B: BB 01 B



Summary for Pond BB 01 S: BB 01 S

Inflow Area = 0.714 ac, 1.93% Impervious, Inflow Depth = 1.68" for 2 yr event
Inflow = 0.90 cfs @ 12.27 hrs, Volume= 0.100 af
Outflow = 0.16 cfs @ 13.11 hrs, Volume= 0.100 af, Atten= 82%, Lag= 50.7 min
Primary = 0.16 cfs @ 13.11 hrs, Volume= 0.100 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 46.70' @ 13.11 hrs Surf.Area= 0 sf Storage= 1,517 cf

Plug-Flow detention time= 79.1 min calculated for 0.100 af (100% of inflow)
Center-of-Mass det. time= 78.6 min (918.5 - 839.9)

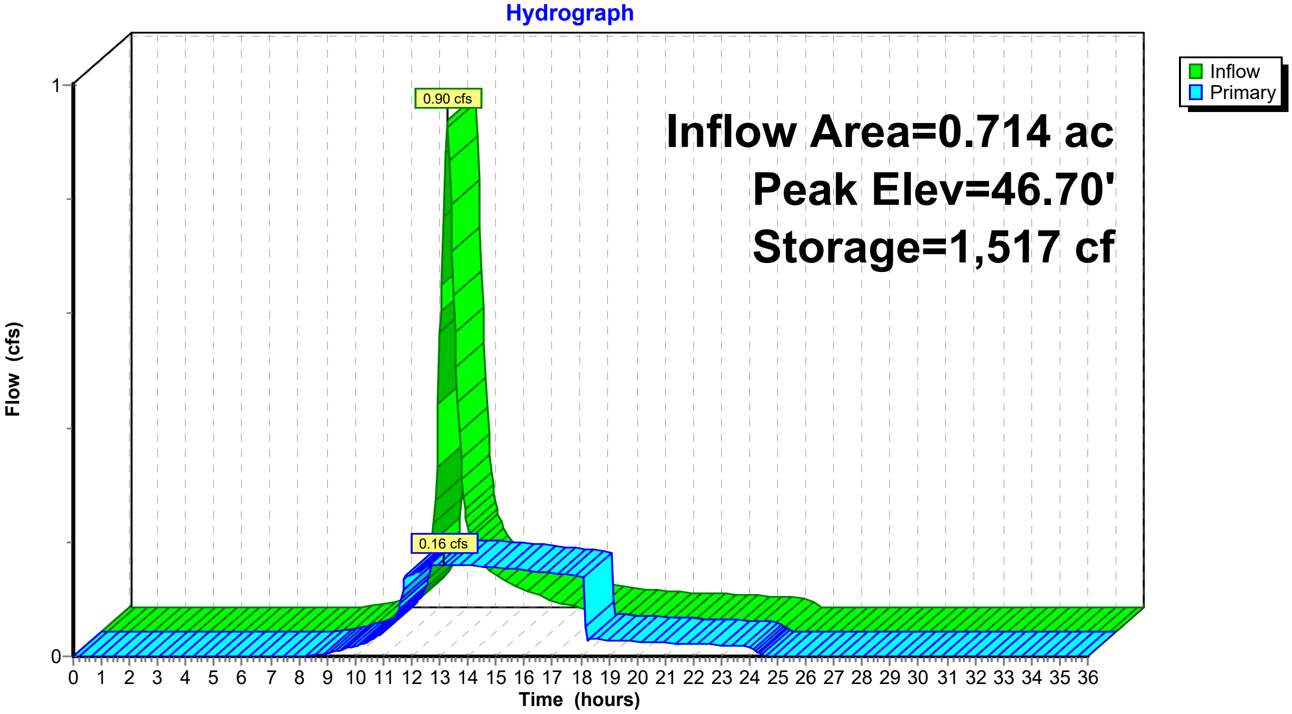
Volume	Invert	Avail.Storage	Storage Description
#1	45.65'	8,017 cf	**Custom Stage Data**Listed below

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
45.65	0	0
46.48	16	16
46.98	3,378	3,394
47.48	3,405	6,799
47.98	1,218	8,017

Device	Routing	Invert	Outlet Devices
#1	Primary	45.65'	**2.5" Vert. Orifice/Grate** C= 0.600
#2	Primary	46.98'	**4.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	46.98'	**5.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.16 cfs @ 13.11 hrs HW=46.70' TW=45.46' (Dynamic Tailwater)
├─**1=Orifice/Grate** (Orifice Controls 0.16 cfs @ 4.69 fps)
├─**2=Orifice/Grate** (Controls 0.00 cfs)
└─**3=Orifice/Grate** (Controls 0.00 cfs)

Pond BB 01 S: BB 01 S



Summary for Pond BB 06 B: BB 06 B

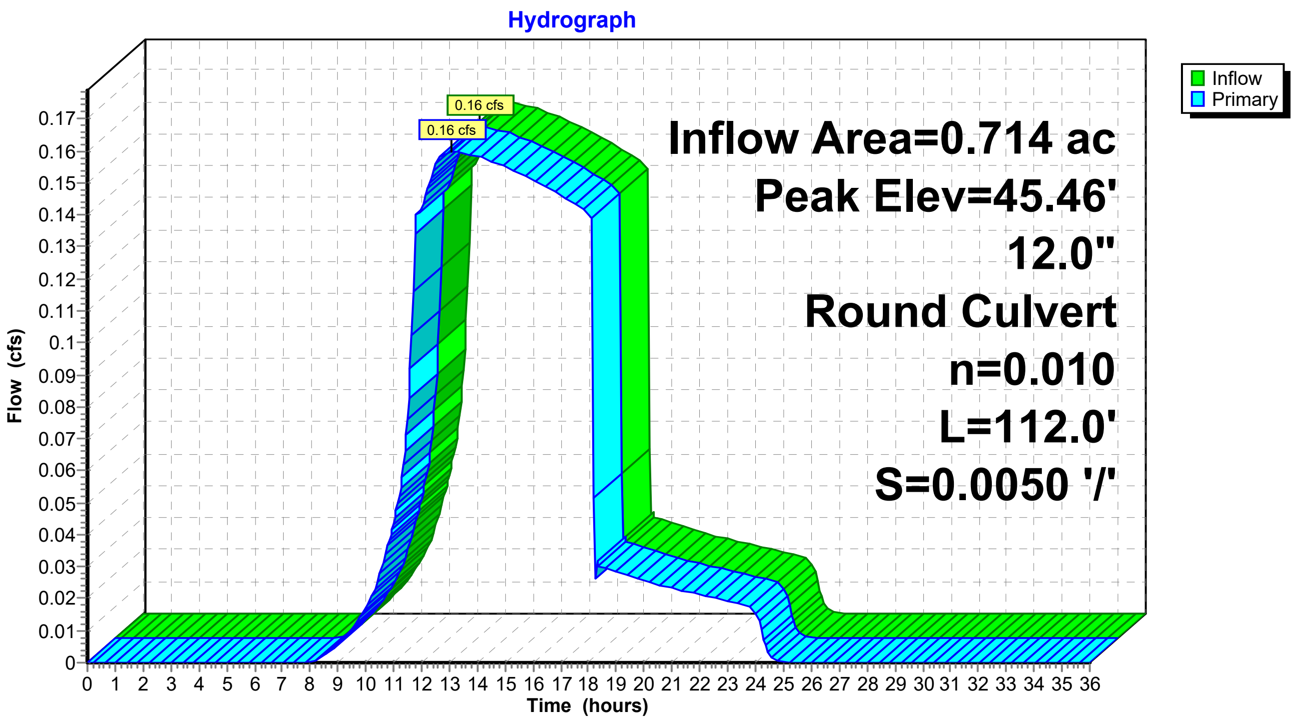
Inflow Area =	0.714 ac,	1.93% Impervious,	Inflow Depth = 1.68"	for 2 yr event
Inflow =	0.16 cfs @	13.11 hrs, Volume=	0.100 af	
Outflow =	0.16 cfs @	13.11 hrs, Volume=	0.100 af, Atten= 0%, Lag= 0.0 min	
Primary =	0.16 cfs @	13.11 hrs, Volume=	0.100 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 45.46' @ 13.11 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	45.25'	**12.0" Round Culvert** L= 112.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 45.25' / 44.69' S= 0.0050 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=0.16 cfs @ 13.11 hrs HW=45.46' TW=44.71' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 0.16 cfs @ 2.09 fps)

Pond BB 06 B: BB 06 B



Summary for Pond BB 07 B: BB 07 B

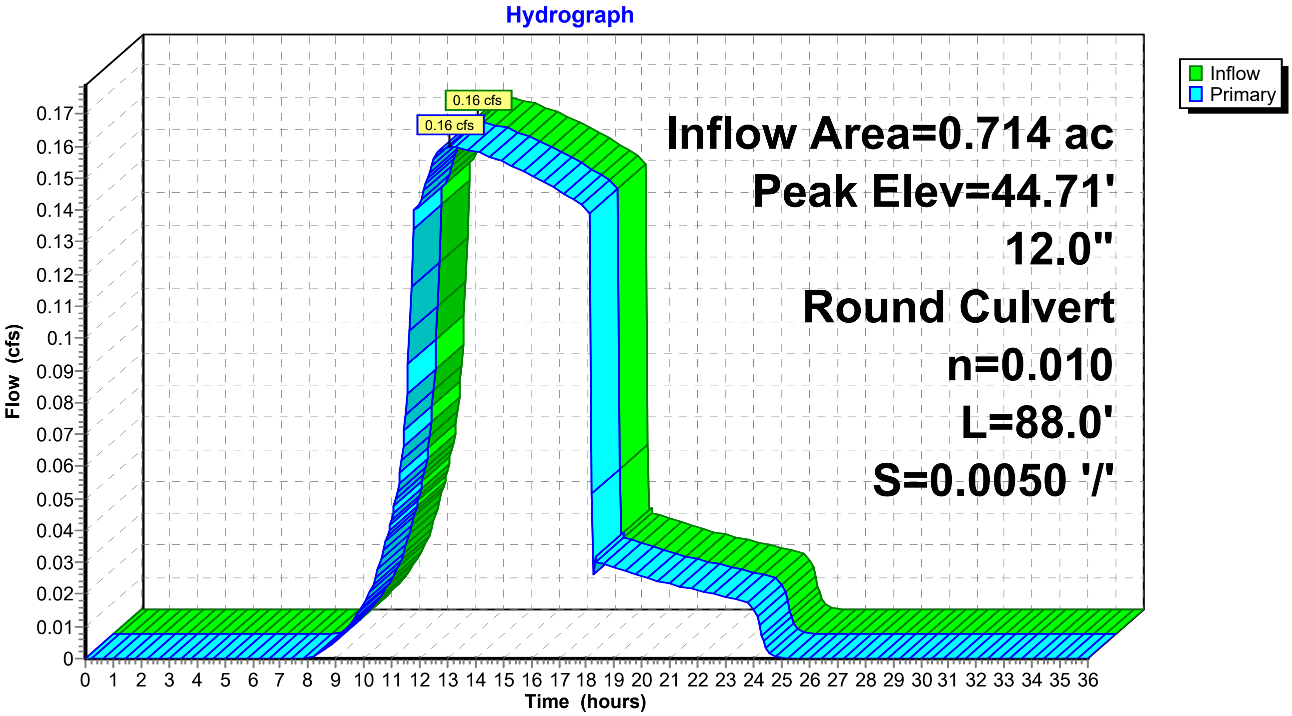
Inflow Area =	0.714 ac,	1.93% Impervious,	Inflow Depth = 1.68"	for 2 yr event
Inflow =	0.16 cfs @	13.11 hrs, Volume=	0.100 af	
Outflow =	0.16 cfs @	13.11 hrs, Volume=	0.100 af, Atten= 0%, Lag= 0.0 min	
Primary =	0.16 cfs @	13.11 hrs, Volume=	0.100 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 44.71' @ 13.11 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	44.50'	**12.0" Round Culvert** L= 88.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 44.50' / 44.06' S= 0.0050 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=0.16 cfs @ 13.11 hrs HW=44.71' TW=44.09' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 0.16 cfs @ 2.07 fps)

Pond BB 07 B: BB 07 B



Summary for Pond BB 11 B: BB 11 B

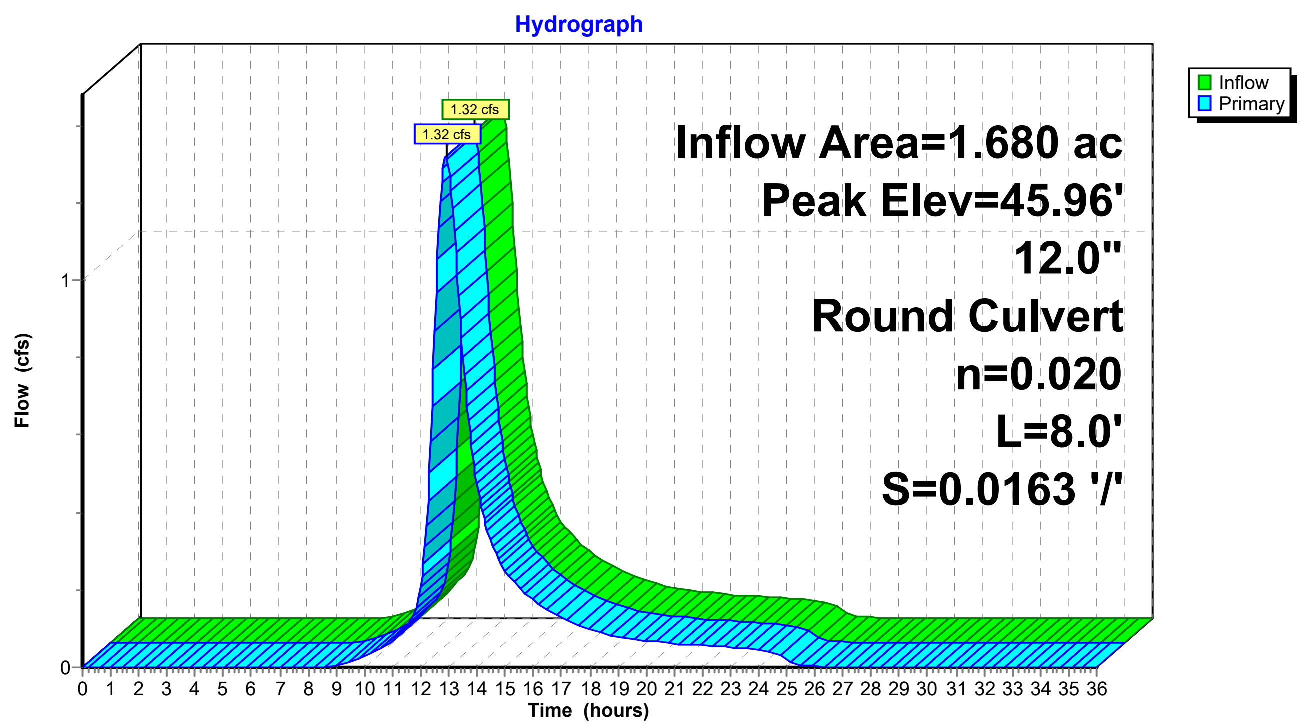
Inflow Area = 1.680 ac, 0.00% Impervious, Inflow Depth = 1.83" for 2 yr event
Inflow = 1.32 cfs @ 12.90 hrs, Volume= 0.256 af
Outflow = 1.32 cfs @ 12.90 hrs, Volume= 0.256 af, Atten= 0%, Lag= 0.0 min
Primary = 1.32 cfs @ 12.90 hrs, Volume= 0.256 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 45.96' @ 12.90 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	45.25'	**12.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 45.25' / 45.12' S= 0.0163 '/' Cc= 0.900 n= 0.020, Flow Area= 0.79 sf

Primary OutFlow Max=1.32 cfs @ 12.90 hrs HW=45.96' TW=45.04' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 1.32 cfs @ 3.10 fps)

Pond BB 11 B: BB 11 B



Summary for Pond BB 11 S: BB 11 S

Inflow Area = 1.680 ac, 0.00% Impervious, Inflow Depth = 1.83" for 2 yr event
Inflow = 1.32 cfs @ 12.90 hrs, Volume= 0.256 af
Outflow = 1.04 cfs @ 13.27 hrs, Volume= 0.256 af, Atten= 21%, Lag= 22.7 min
Primary = 1.04 cfs @ 13.27 hrs, Volume= 0.256 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 45.08' @ 13.27 hrs Surf.Area= 0 sf Storage= 715 cf

Plug-Flow detention time= 3.9 min calculated for 0.255 af (100% of inflow)
Center-of-Mass det. time= 4.0 min (885.4 - 881.4)

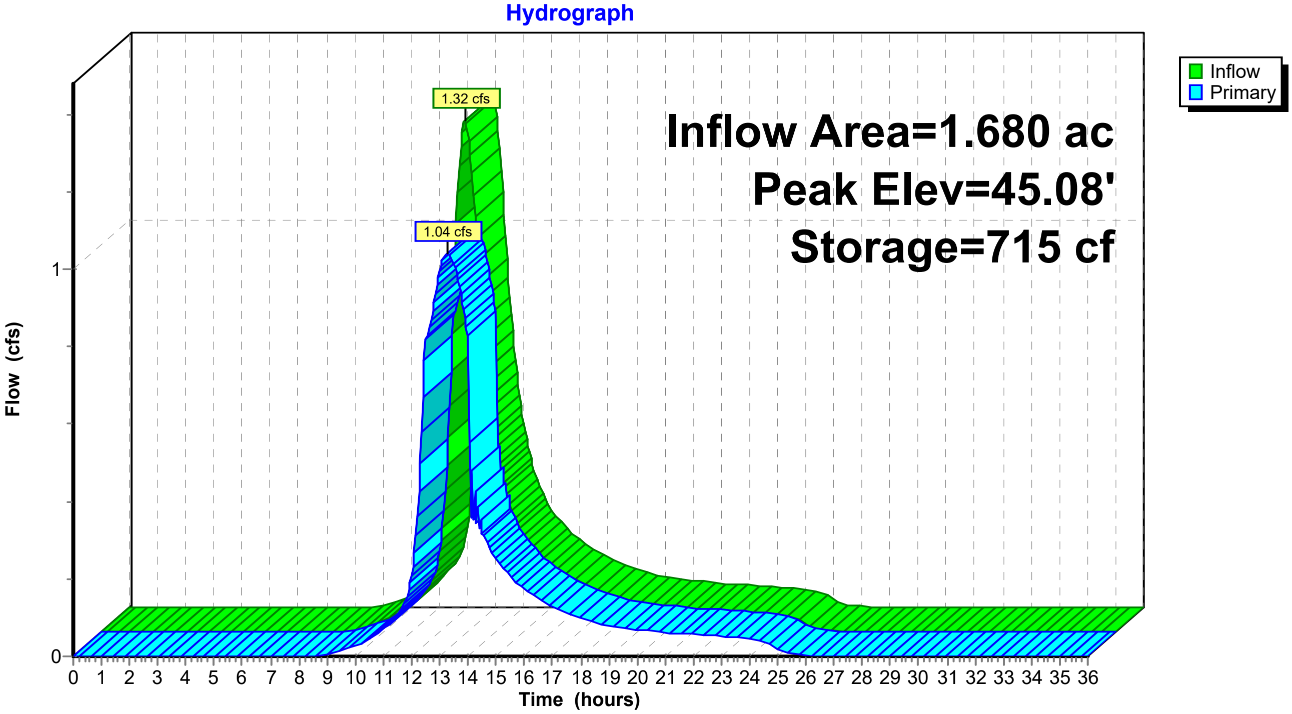
Volume	Invert	Avail.Storage	Storage Description
#1	44.14'	7,432 cf	**Custom Stage Data**Listed below

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
44.14	0	0
44.97	16	16
45.47	3,131	3,147
45.97	3,156	6,303
46.47	1,129	7,432

Device	Routing	Invert	Outlet Devices
#1	Primary	44.14'	**2.5" Vert. Orifice/Grate** C= 0.600
#2	Primary	44.47'	**8.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	45.47'	**6.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=1.04 cfs @ 13.27 hrs HW=45.08' TW=44.09' (Dynamic Tailwater)
1=Orifice/Grate (Orifice Controls 0.15 cfs @ 4.41 fps)
2=Orifice/Grate (Orifice Controls 0.89 cfs @ 2.66 fps)
3=Orifice/Grate (Controls 0.00 cfs)

Pond BB 11 S: BB 11 S



Summary for Pond PR-4: SB 01 DMH

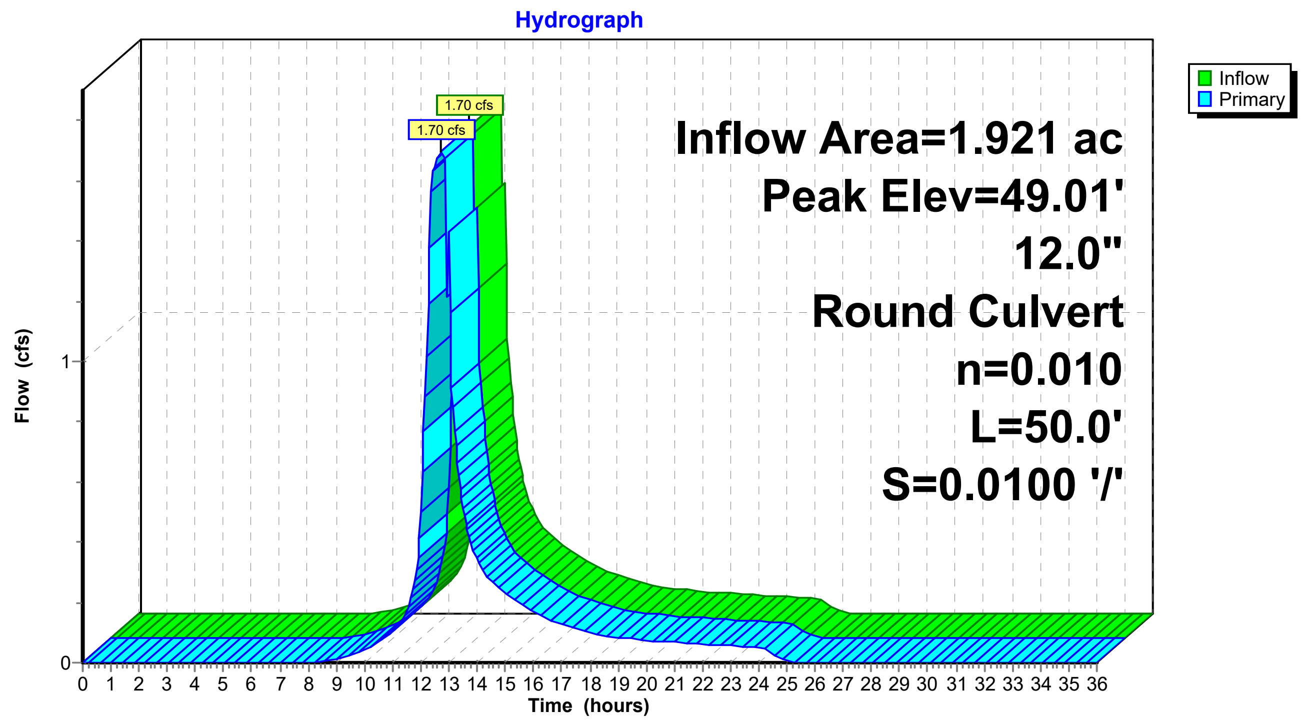
Inflow Area =	1.921 ac,	1.31% Impervious,	Inflow Depth = 1.79"	for 2 yr event	
Inflow =	1.70 cfs @	12.73 hrs,	Volume=	0.287 af	
Outflow =	1.70 cfs @	12.73 hrs,	Volume=	0.287 af,	Atten= 0%, Lag= 0.0 min
Primary =	1.70 cfs @	12.73 hrs,	Volume=	0.287 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 49.01' @ 12.73 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	48.30'	**12.0" Round Culvert** L= 50.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 48.30' / 47.80' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=1.70 cfs @ 12.73 hrs HW=49.01' TW=0.00' (Dynamic Tailwater)
1=Culvert (Inlet Controls 1.70 cfs @ 2.86 fps)

Pond PR-4: SB 01 DMH



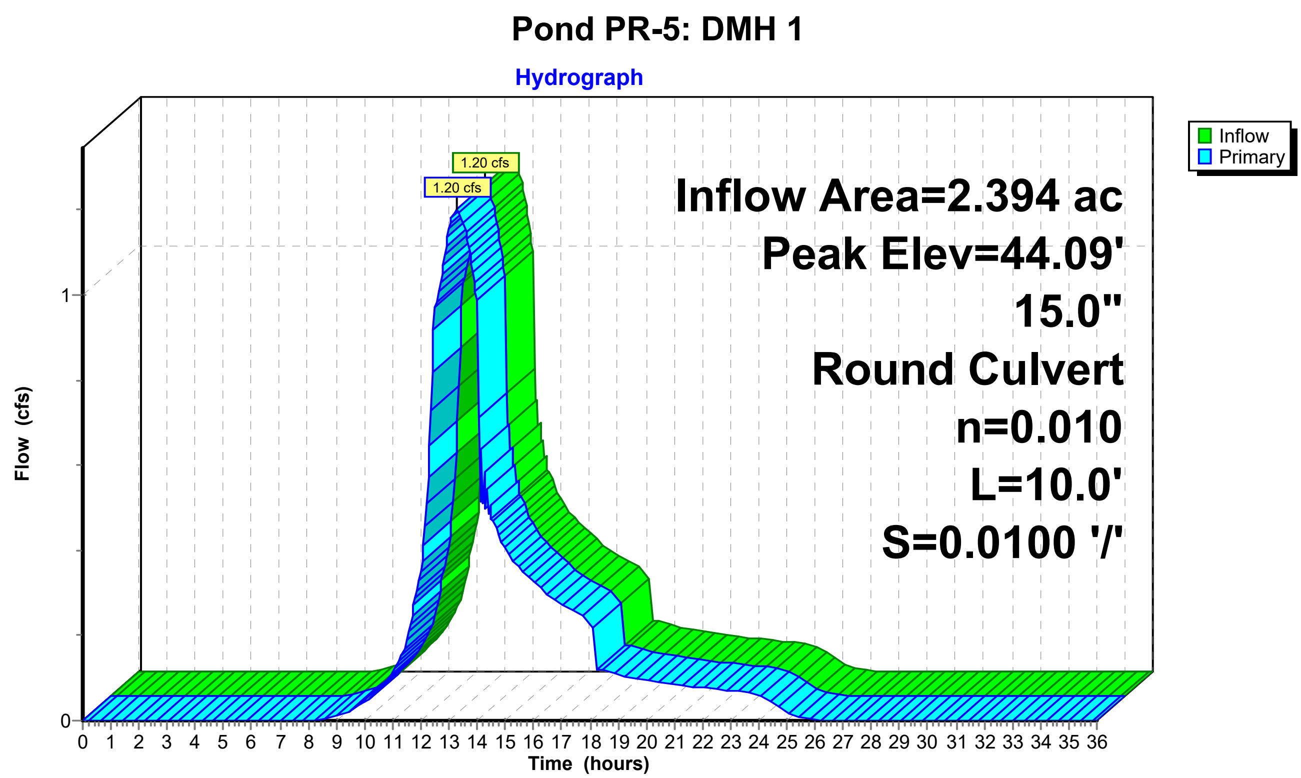
Summary for Pond PR-5: DMH 1

Inflow Area =	2.394 ac,	0.58% Impervious,	Inflow Depth = 1.78"	for 2 yr event	
Inflow =	1.20 cfs @	13.27 hrs,	Volume=	0.356 af	
Outflow =	1.20 cfs @	13.27 hrs,	Volume=	0.356 af,	Atten= 0%, Lag= 0.0 min
Primary =	1.20 cfs @	13.27 hrs,	Volume=	0.356 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 44.09' @ 13.27 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	43.50'	**15.0" Round Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 43.50' / 43.40' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 1.23 sf

Primary OutFlow Max=1.20 cfs @ 13.27 hrs HW=44.09' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 1.20 cfs @ 3.07 fps)



Summary for Pond SB 01 B: SB 01 B

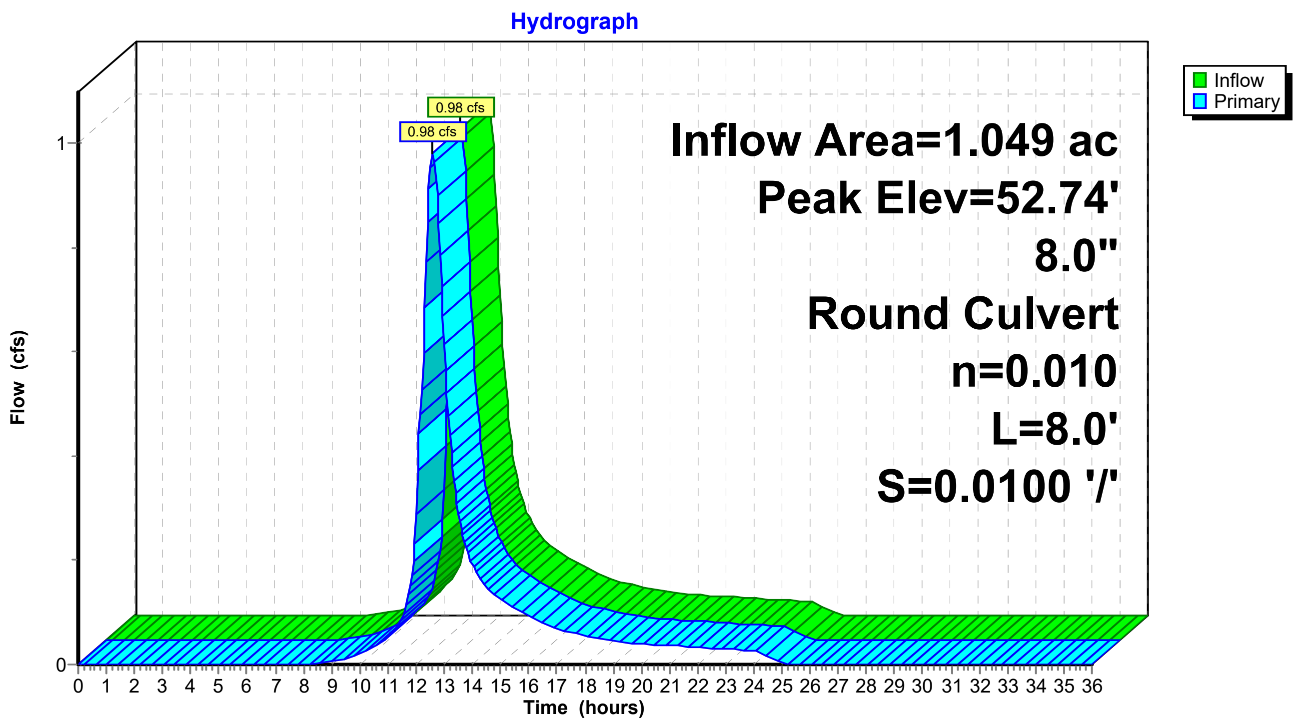
Inflow Area = 1.049 ac, 2.41% Impervious, Inflow Depth = 1.77" for 2 yr event
Inflow = 0.98 cfs @ 12.58 hrs, Volume= 0.155 af
Outflow = 0.98 cfs @ 12.58 hrs, Volume= 0.155 af, Atten= 0%, Lag= 0.0 min
Primary = 0.98 cfs @ 12.58 hrs, Volume= 0.155 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 52.74' @ 12.58 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	52.00'	**8.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 52.00' / 51.92' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.35 sf

Primary OutFlow Max=0.98 cfs @ 12.58 hrs HW=52.74' TW=51.49' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 0.98 cfs @ 3.16 fps)

Pond SB 01 B: SB 01 B



Summary for Pond SB 01 S: SB 01 S

Inflow Area = 1.049 ac, 2.41% Impervious, Inflow Depth = 1.77" for 2 yr event
Inflow = 0.98 cfs @ 12.58 hrs, Volume= 0.155 af
Outflow = 0.86 cfs @ 12.79 hrs, Volume= 0.155 af, Atten= 12%, Lag= 12.3 min
Primary = 0.86 cfs @ 12.79 hrs, Volume= 0.155 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 51.50' @ 12.79 hrs Surf.Area= 0 sf Storage= 157 cf

Plug-Flow detention time= 1.5 min calculated for 0.155 af (100% of inflow)
Center-of-Mass det. time= 1.1 min (860.0 - 858.9)

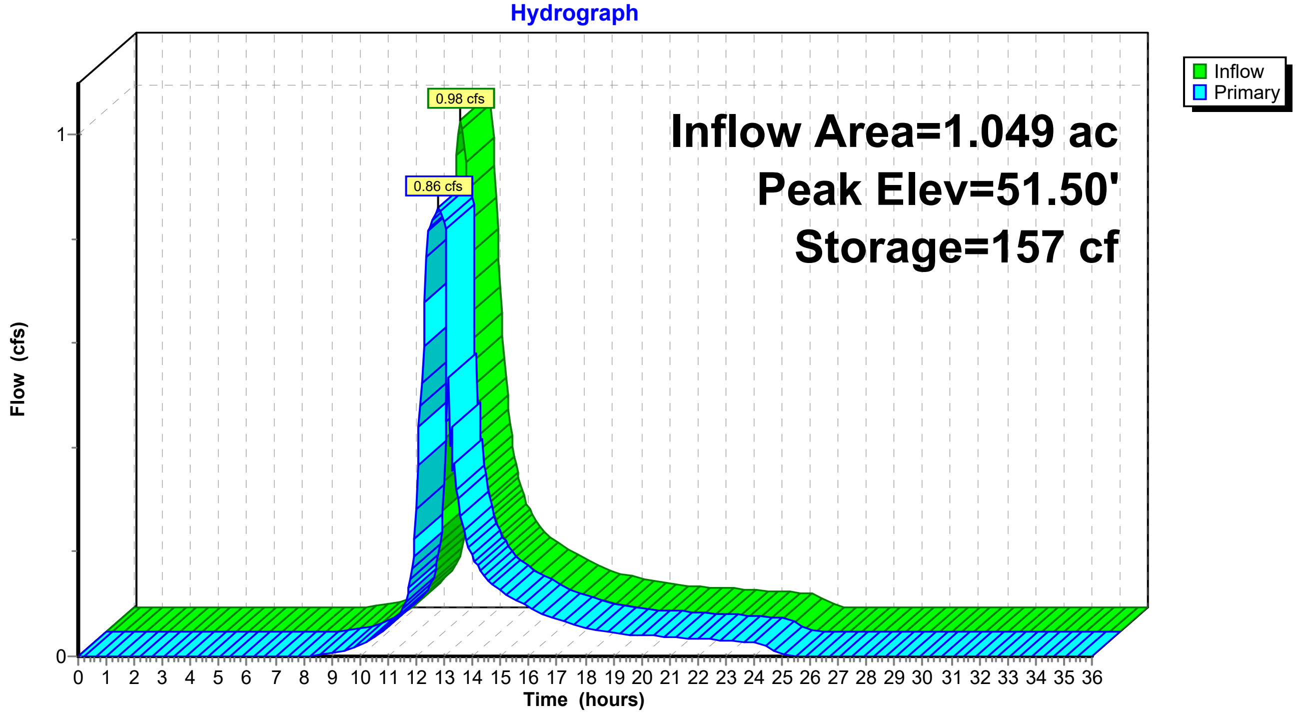
Volume	Invert	Avail.Storage	Storage Description
#1	50.64'	3,084 cf	**Custom Stage Data**Listed below

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
50.64	0	0
51.47	16	16
51.97	2,170	2,186
52.47	898	3,084

Device	Routing	Invert	Outlet Devices
#1	Primary	50.64'	**4.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	50.97'	**6.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	51.47'	**8.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.86 cfs @ 12.79 hrs HW=51.50' TW=50.49' (Dynamic Tailwater)
├─**1=Orifice/Grate** (Orifice Controls 0.35 cfs @ 4.02 fps)
├─**2=Orifice/Grate** (Orifice Controls 0.50 cfs @ 2.56 fps)
└─**3=Orifice/Grate** (Orifice Controls 0.00 cfs @ 0.61 fps)

Pond SB 01 S: SB 01 S



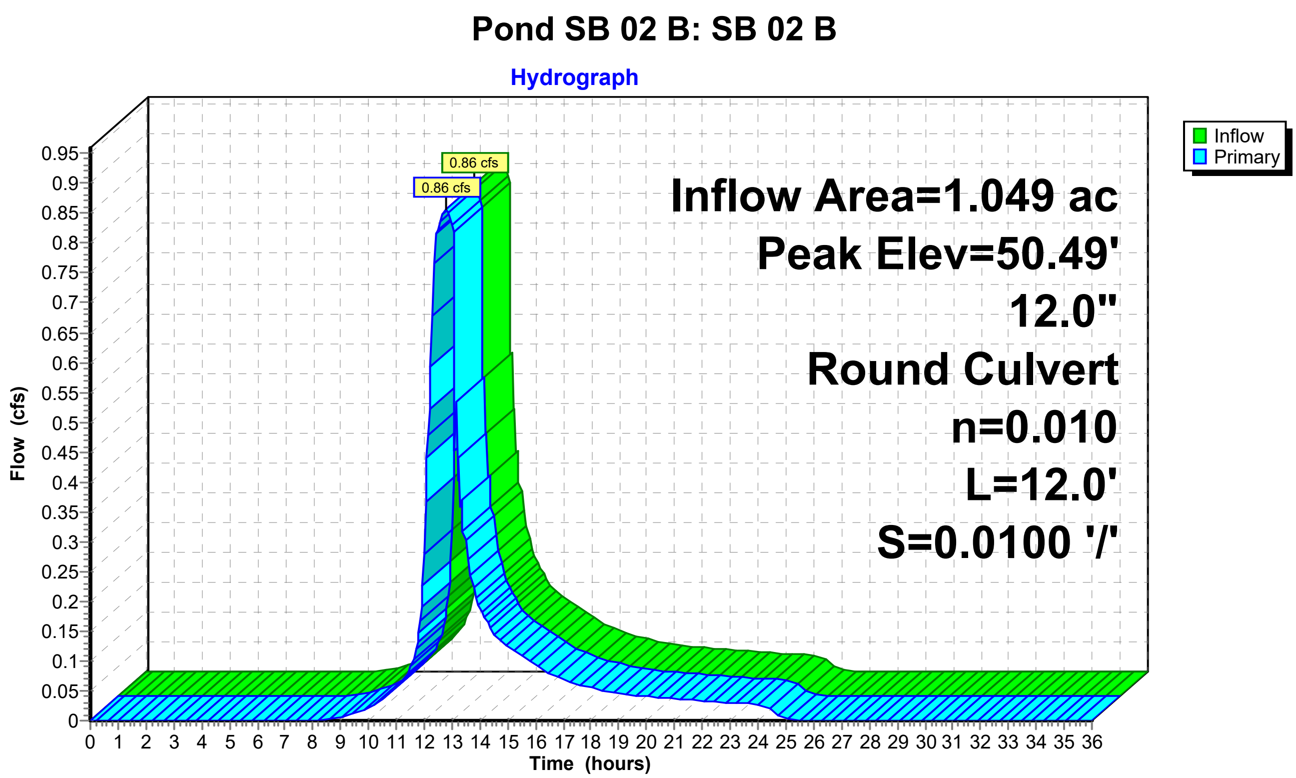
Summary for Pond SB 02 B: SB 02 B

Inflow Area =	1.049 ac,	2.41% Impervious, Inflow Depth = 1.77"	for 2 yr event	
Inflow =	0.86 cfs @	12.79 hrs, Volume=	0.155 af	
Outflow =	0.86 cfs @	12.79 hrs, Volume=	0.155 af,	Atten= 0%, Lag= 0.0 min
Primary =	0.86 cfs @	12.79 hrs, Volume=	0.155 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 50.49' @ 12.79 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	49.97'	**12.0" Round Culvert** L= 12.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 49.97' / 49.85' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=0.86 cfs @ 12.79 hrs HW=50.49' TW=49.01' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 0.86 cfs @ 3.01 fps)



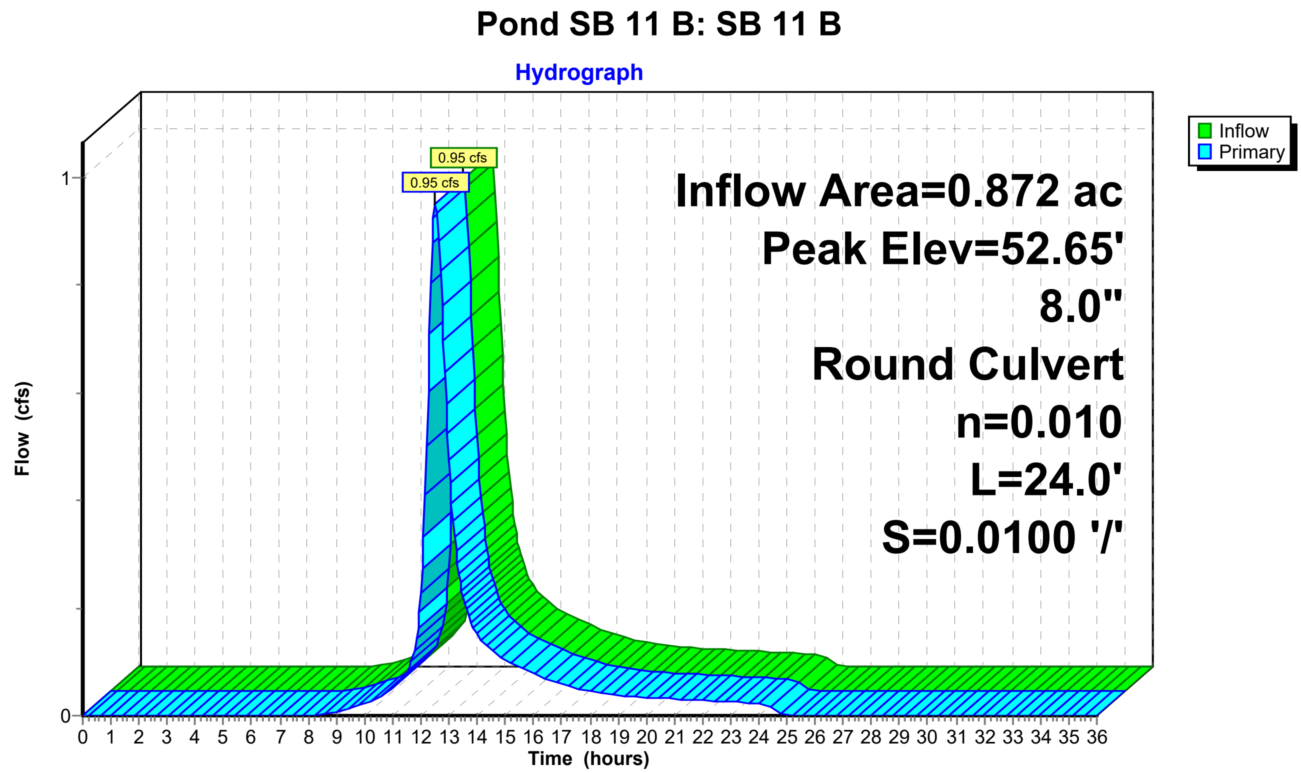
Summary for Pond SB 11 B: SB 11 B

Inflow Area =	0.872 ac,	0.00% Impervious, Inflow Depth = 1.83"	for 2 yr event	
Inflow =	0.95 cfs @	12.52 hrs, Volume=	0.133 af	
Outflow =	0.95 cfs @	12.52 hrs, Volume=	0.133 af,	Atten= 0%, Lag= 0.0 min
Primary =	0.95 cfs @	12.52 hrs, Volume=	0.133 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 52.65' @ 12.52 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	52.00'	**8.0" Round Culvert** L= 24.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 52.00' / 51.76' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.35 sf

Primary OutFlow Max=0.95 cfs @ 12.52 hrs HW=52.65' TW=51.68' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 0.95 cfs @ 2.74 fps)



Summary for Pond SB 11 S: SB 11 S

Inflow Area = 0.872 ac, 0.00% Impervious, Inflow Depth = 1.83" for 2 yr event
Inflow = 0.95 cfs @ 12.52 hrs, Volume= 0.133 af
Outflow = 0.84 cfs @ 12.68 hrs, Volume= 0.133 af, Atten= 11%, Lag= 9.9 min
Primary = 0.84 cfs @ 12.68 hrs, Volume= 0.133 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 51.69' @ 12.68 hrs Surf.Area= 0 sf Storage= 109 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.9 min (855.0 - 854.1)

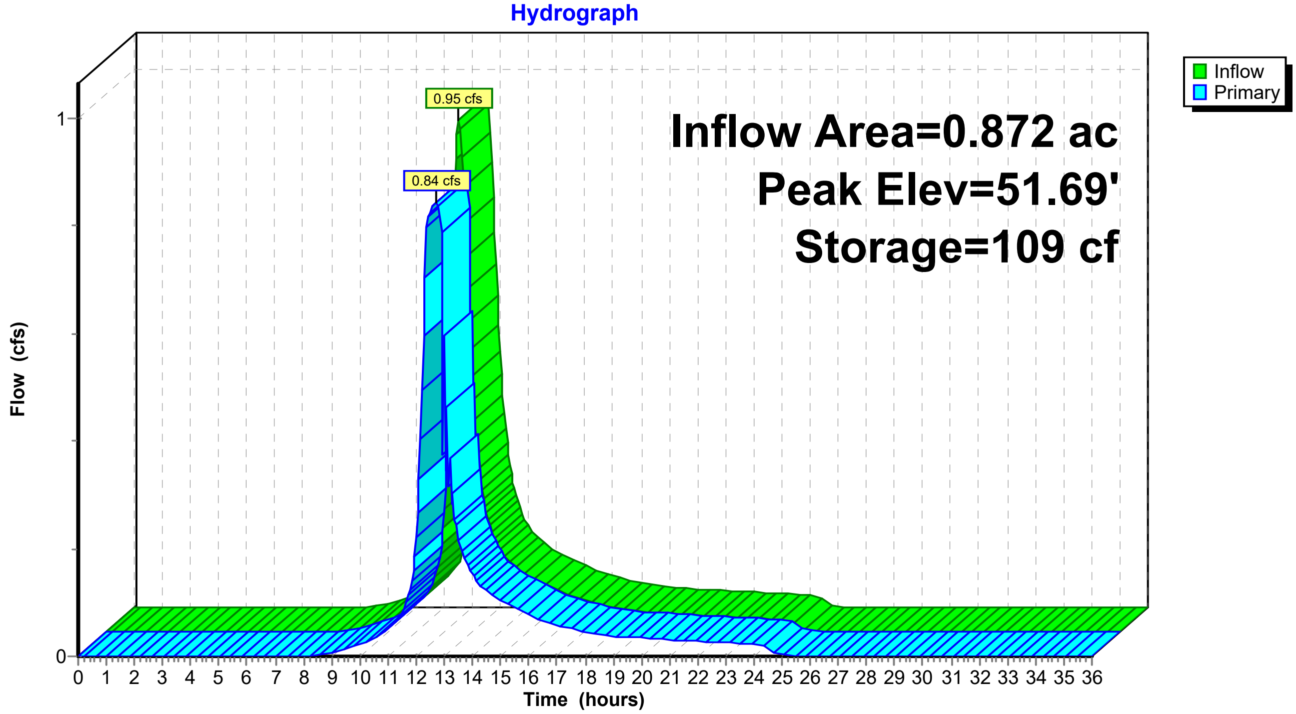
Volume	Invert	Avail.Storage	Storage Description
#1	50.84'	2,892 cf	**Custom Stage Data** Listed below

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
50.84	0	0
51.67	16	16
52.17	2,035	2,051
52.67	841	2,892

Device	Routing	Invert	Outlet Devices
#1	Primary	50.84'	**4.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	51.17'	**6.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	51.67'	**6.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.84 cfs @ 12.68 hrs HW=51.69' TW=50.64' (Dynamic Tailwater)
├─**1=Orifice/Grate** (Orifice Controls 0.35 cfs @ 3.99 fps)
├─**2=Orifice/Grate** (Orifice Controls 0.49 cfs @ 2.51 fps)
└─**3=Orifice/Grate** (Orifice Controls 0.00 cfs @ 0.51 fps)

Pond SB 11 S: SB 11 S



Summary for Pond SB 12 B: SB 12 B

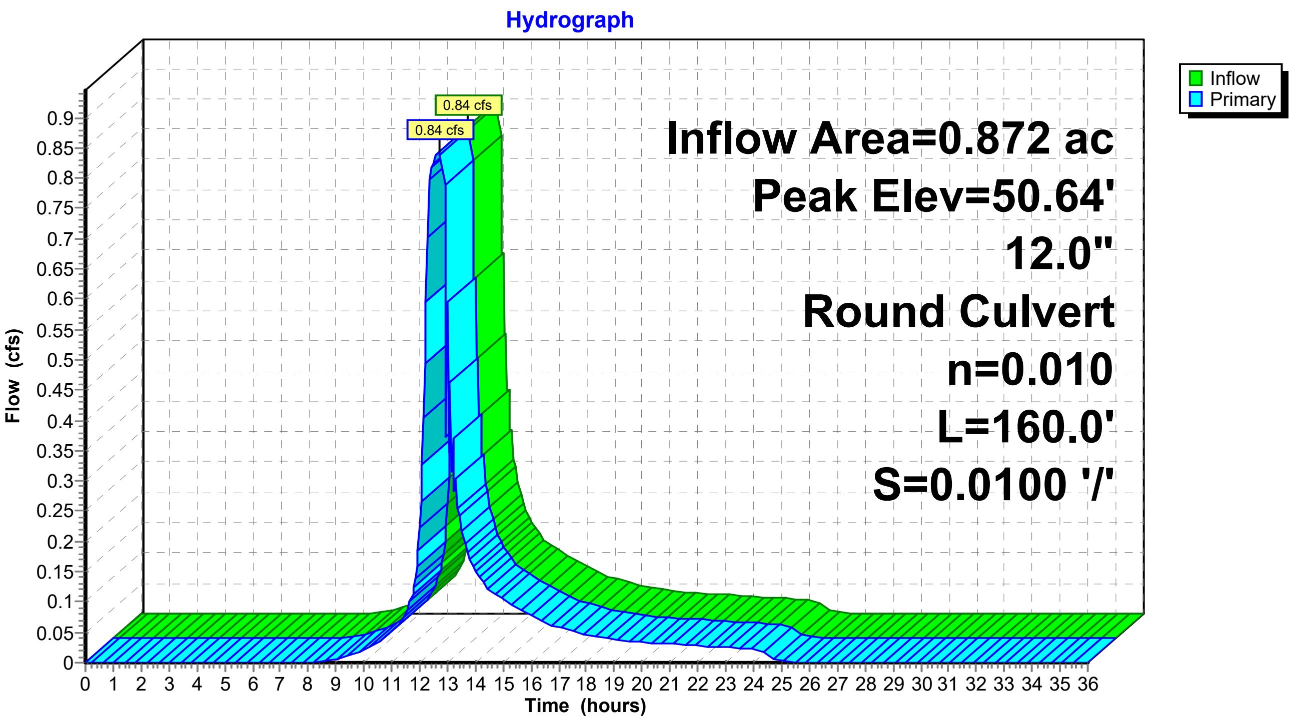
Inflow Area = 0.872 ac, 0.00% Impervious, Inflow Depth = 1.83" for 2 yr event
Inflow = 0.84 cfs @ 12.68 hrs, Volume= 0.133 af
Outflow = 0.84 cfs @ 12.68 hrs, Volume= 0.133 af, Atten= 0%, Lag= 0.0 min
Primary = 0.84 cfs @ 12.68 hrs, Volume= 0.133 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 50.64' @ 12.68 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	50.17'	**12.0" Round Culvert** L= 160.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 50.17' / 48.57' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=0.84 cfs @ 12.68 hrs HW=50.64' TW=49.01' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 0.84 cfs @ 2.33 fps)

Pond SB 12 B: SB 12 B

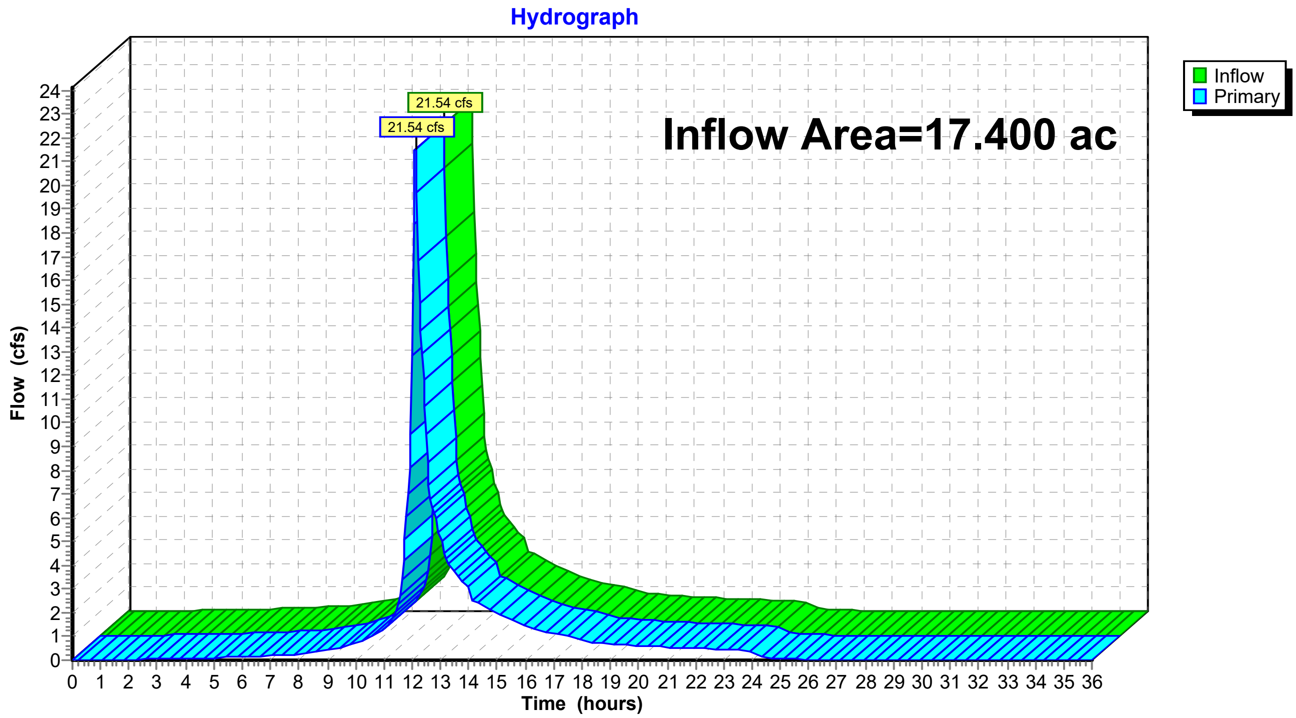


Summary for Link POA: POA

Inflow Area = 17.400 ac, 49.60% Impervious, Inflow Depth > 1.77" for 2 yr event
Inflow = 21.54 cfs @ 12.11 hrs, Volume= 2.564 af
Primary = 21.54 cfs @ 12.11 hrs, Volume= 2.564 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Link POA: POA



Summary for Subcatchment PR-1: PR-1

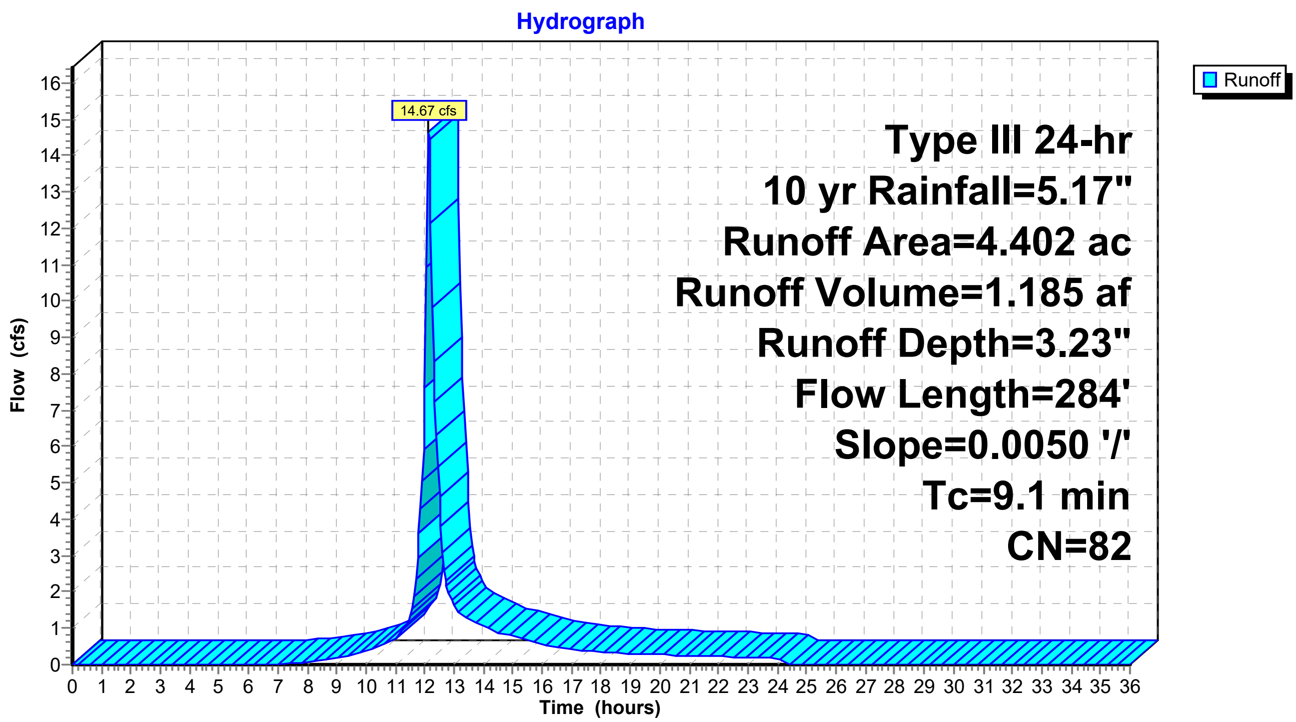
Runoff = 14.67 cfs @ 12.13 hrs, Volume= 1.185 af, Depth= 3.23"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=5.17"

Area (ac)	CN	Description
1.892	61	>75% Grass cover, Good, HSG B
2.510	98	Paved parking, HSG B
4.402	82	Weighted Average
1.892		42.98% Pervious Area
2.510		57.02% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	50	0.0050	0.69		**Sheet Flow, A-B**
					Smooth surfaces n= 0.011 P2= 3.20"
7.9	234	0.0050	0.49		**Shallow Concentrated Flow, B-C**
					Short Grass Pasture Kv= 7.0 fps
9.1	284	Total			

Subcatchment PR-1: PR-1



Summary for Subcatchment PR-1A: PR-1A

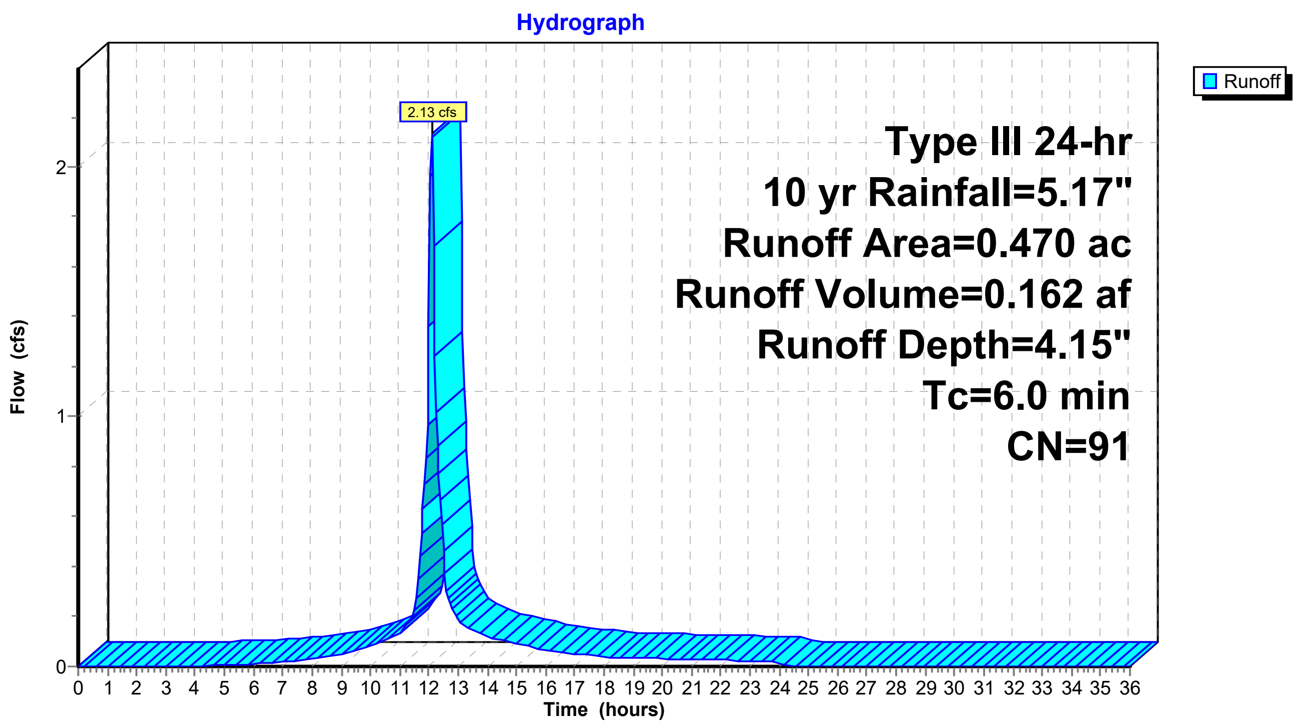
Runoff = 2.13 cfs @ 12.09 hrs, Volume= 0.162 af, Depth= 4.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=5.17"

Area (ac)	CN	Description
0.090	61	>75% Grass cover, Good, HSG B
0.380	98	Paved parking, HSG B
0.470	91	Weighted Average
0.090		19.15% Pervious Area
0.380		80.85% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-1A: PR-1A



Summary for Subcatchment PR-1B: PR-1B

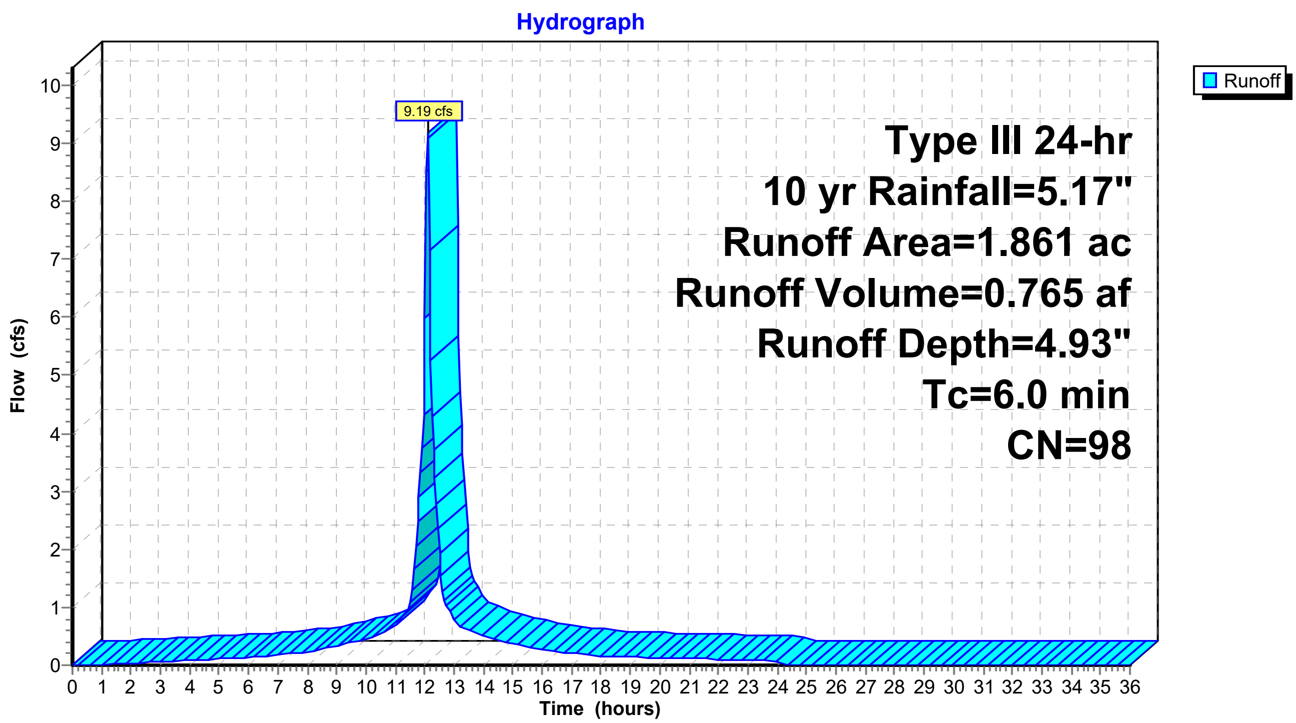
Runoff = 9.19 cfs @ 12.09 hrs, Volume= 0.765 af, Depth= 4.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=5.17"

Area (ac)	CN	Description
1.861	98	Roofs, HSG B
1.861		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-1B: PR-1B



Summary for Subcatchment PR-1C: PR-1C

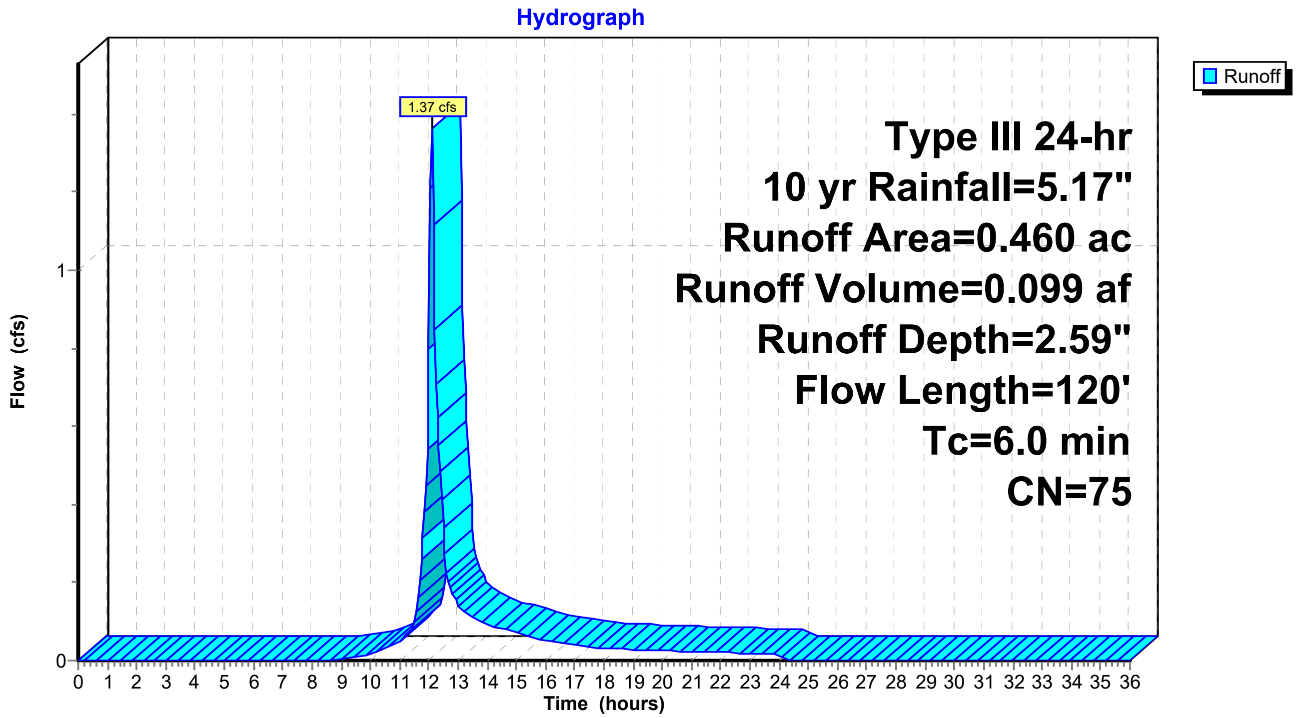
Runoff = 1.37 cfs @ 12.09 hrs, Volume= 0.099 af, Depth= 2.59"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=5.17"

Area (ac)	CN	Description
0.020	55	Woods, Good, HSG B
0.260	61	>75% Grass cover, Good, HSG B
0.180	98	Paved parking, HSG B
0.460	75	Weighted Average
0.280		60.87% Pervious Area
0.180		39.13% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	20	0.0700	0.09		**Sheet Flow, 20' SF** Woods: Light underbrush n= 0.400 P2= 3.20"
1.9	40	0.5000	0.35		**Sheet Flow, 30' SF** Grass: Dense n= 0.240 P2= 3.20"
0.1	12	0.0100	1.61		**Shallow Concentrated Flow, 12' SCF** Unpaved Kv= 16.1 fps
0.2	48	0.0400	4.06		**Shallow Concentrated Flow, 48' SCF** Paved Kv= 20.3 fps
5.8	120	Total, Increased to minimum Tc = 6.0 min			

Subcatchment PR-1C: PR-1C



Summary for Subcatchment PR-1D: PR-1D

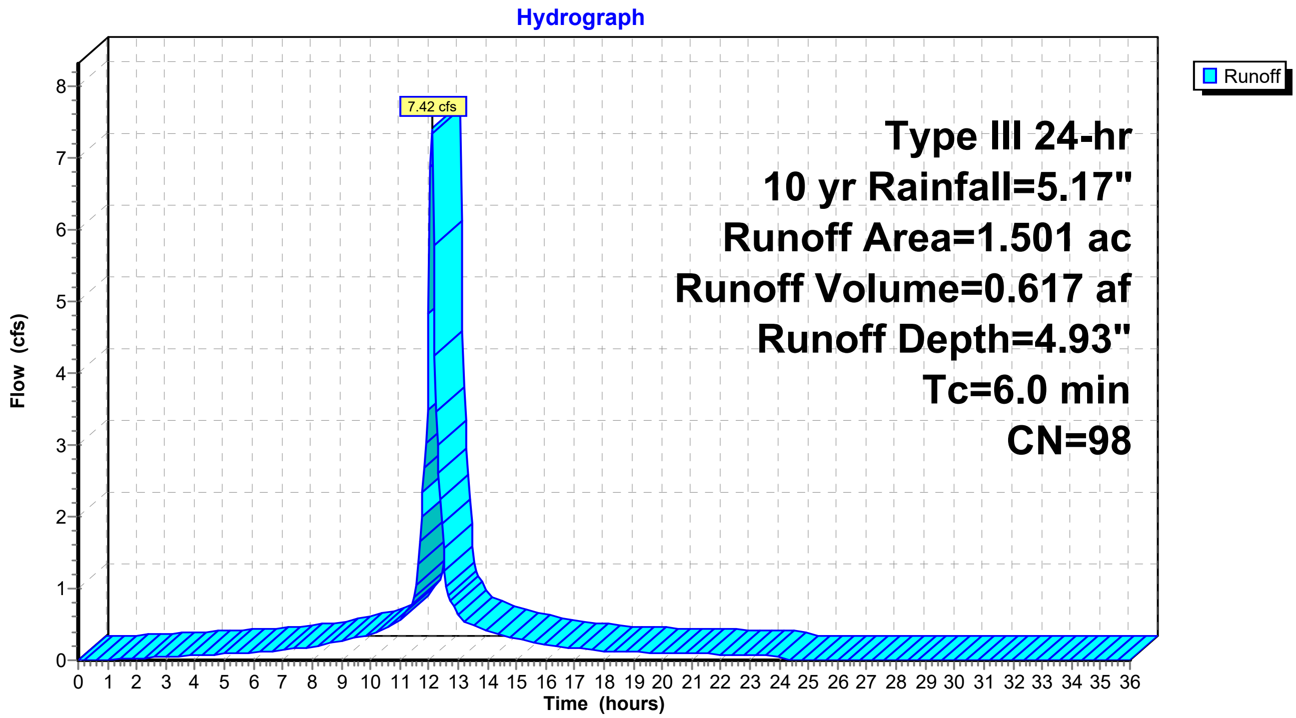
Runoff = 7.42 cfs @ 12.09 hrs, Volume= 0.617 af, Depth= 4.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=5.17"

Area (ac)	CN	Description
1.501	98	Roofs, HSG B
1.501		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-1D: PR-1D



Summary for Subcatchment PR-1E: PR-1E

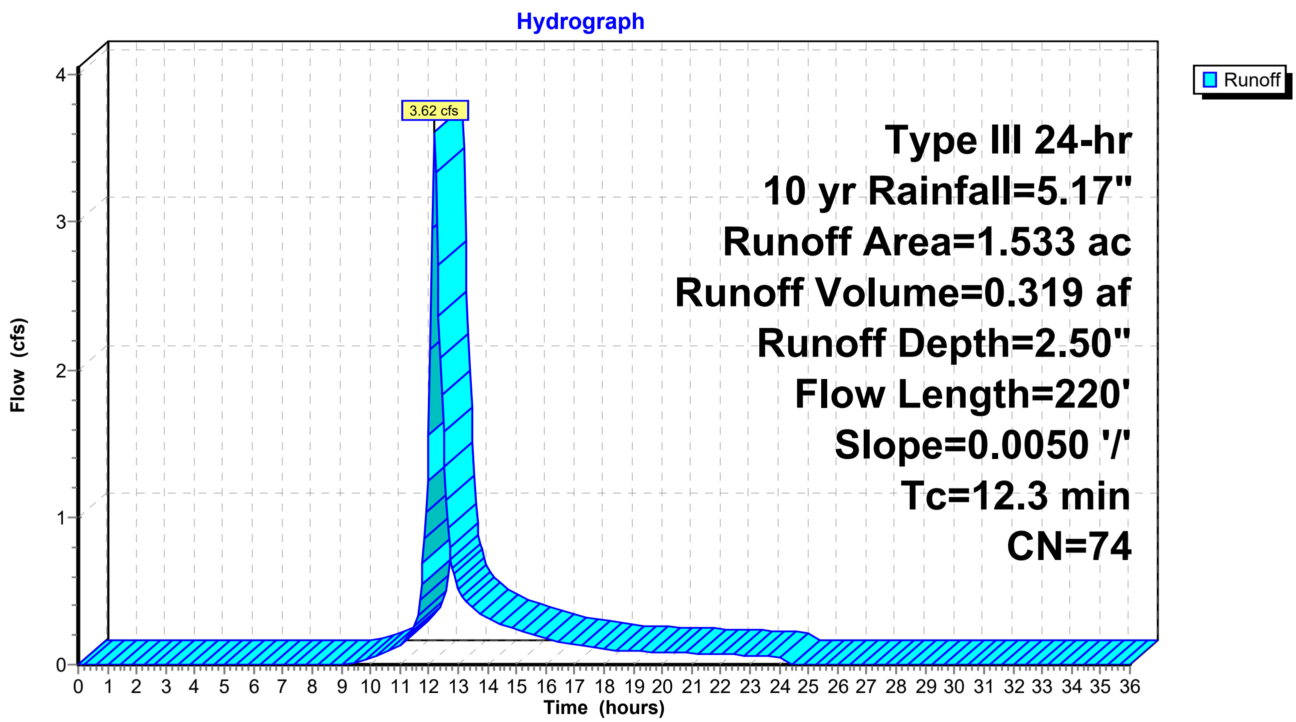
Runoff = 3.62 cfs @ 12.17 hrs, Volume= 0.319 af, Depth= 2.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=5.17"

Area (ac)	CN	Description
1.000	61	>75% Grass cover, Good, HSG B
0.533	98	Paved parking, HSG B
1.533	74	Weighted Average
1.000		65.23% Pervious Area
0.533		34.77% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.8	50	0.0050	0.09		**Sheet Flow, 50' SF** Grass: Short n= 0.150 P2= 3.20"
2.5	170	0.0050	1.14		**Shallow Concentrated Flow, 170' SCF** Unpaved Kv= 16.1 fps
12.3	220	Total			

Subcatchment PR-1E: PR-1E



Summary for Subcatchment PR-2: PR-2

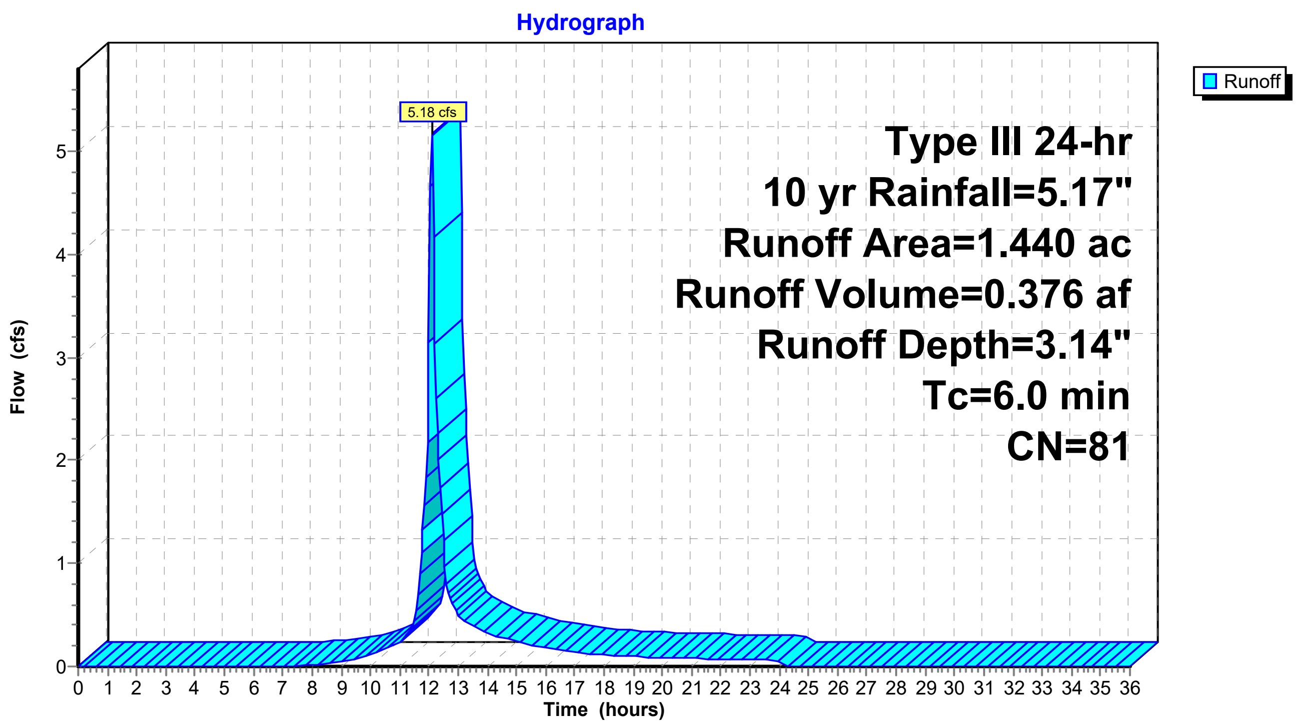
Runoff = 5.18 cfs @ 12.09 hrs, Volume= 0.376 af, Depth= 3.14"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=5.17"

Area (ac)	CN	Description
0.672	61	>75% Grass cover, Good, HSG B
0.768	98	Paved parking, HSG B
1.440	81	Weighted Average
0.672		46.67% Pervious Area
0.768		53.33% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-2: PR-2



Summary for Subcatchment PR-2B: PR-2B

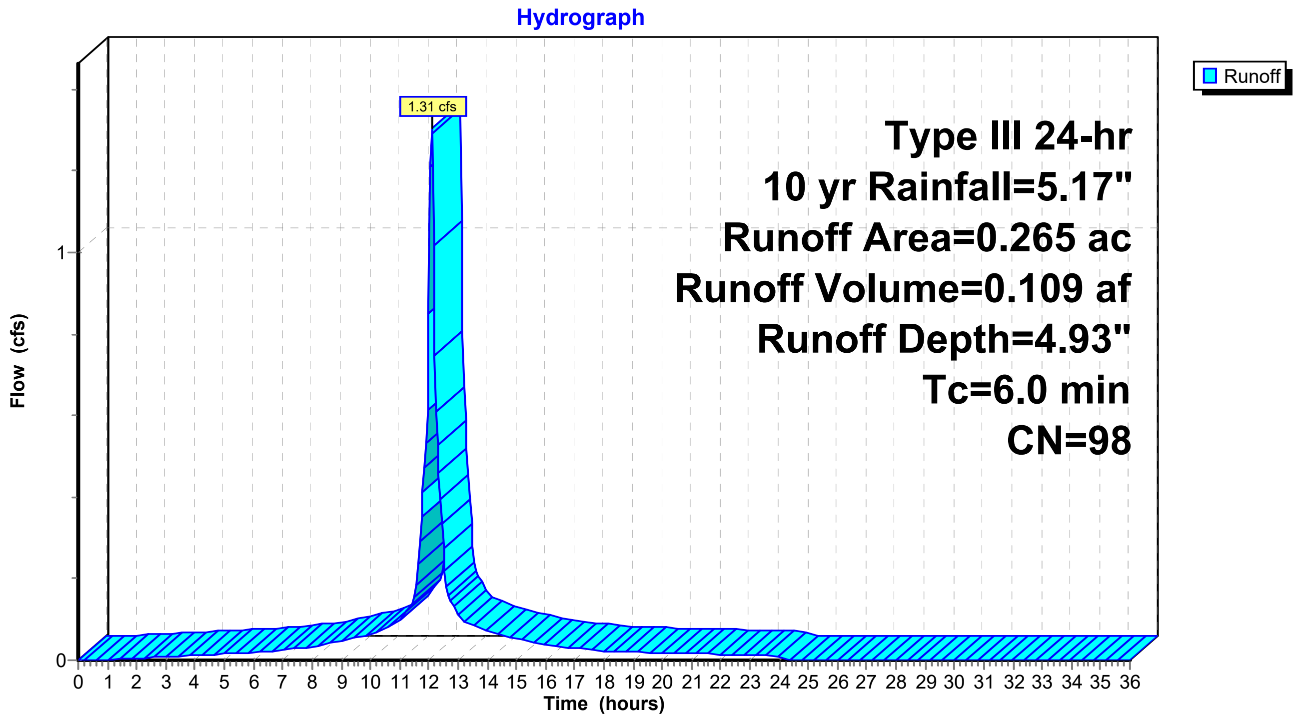
Runoff = 1.31 cfs @ 12.09 hrs, Volume= 0.109 af, Depth= 4.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=5.17"

Area (ac)	CN	Description
0.265	98	Roofs, HSG B
0.265		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-2B: PR-2B



Summary for Subcatchment PR-3A: PR-3A

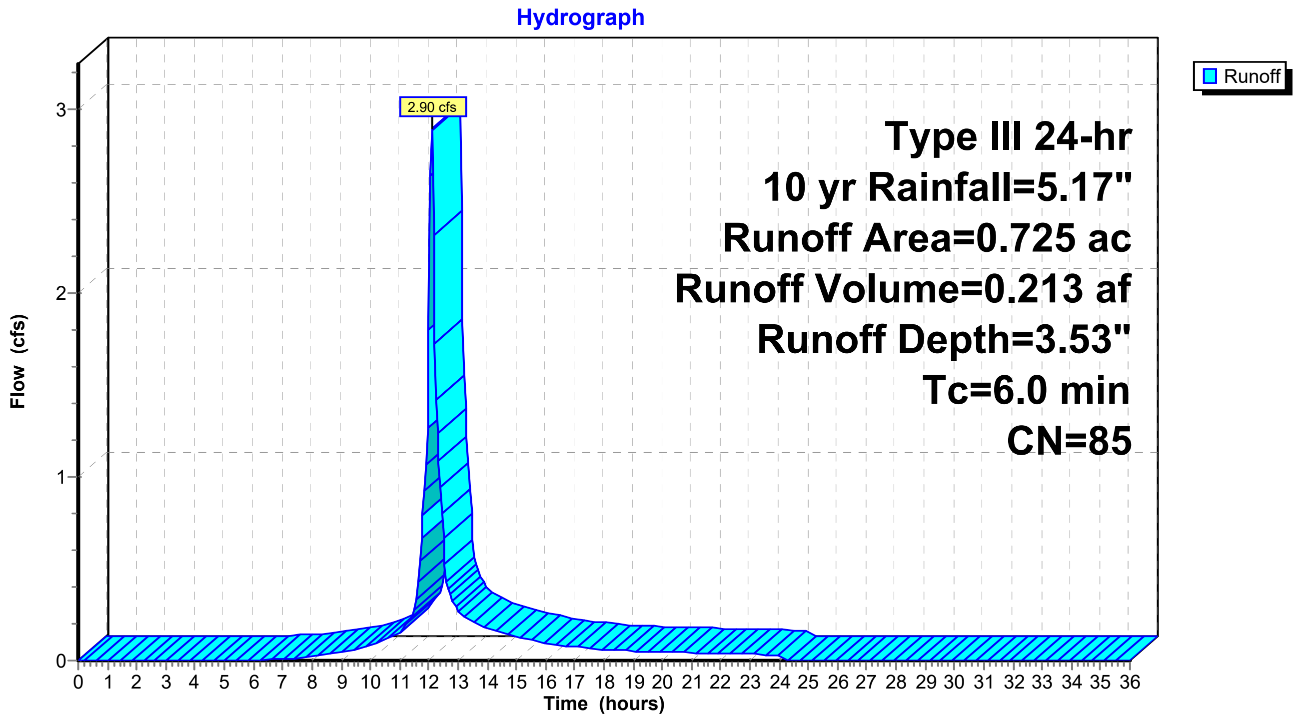
Runoff = 2.90 cfs @ 12.09 hrs, Volume= 0.213 af, Depth= 3.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=5.17"

Area (ac)	CN	Description
0.249	61	>75% Grass cover, Good, HSG B
0.476	98	Paved parking, HSG B
0.725	85	Weighted Average
0.249		34.34% Pervious Area
0.476		65.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-3A: PR-3A



Summary for Subcatchment PR-3B: PR-3B

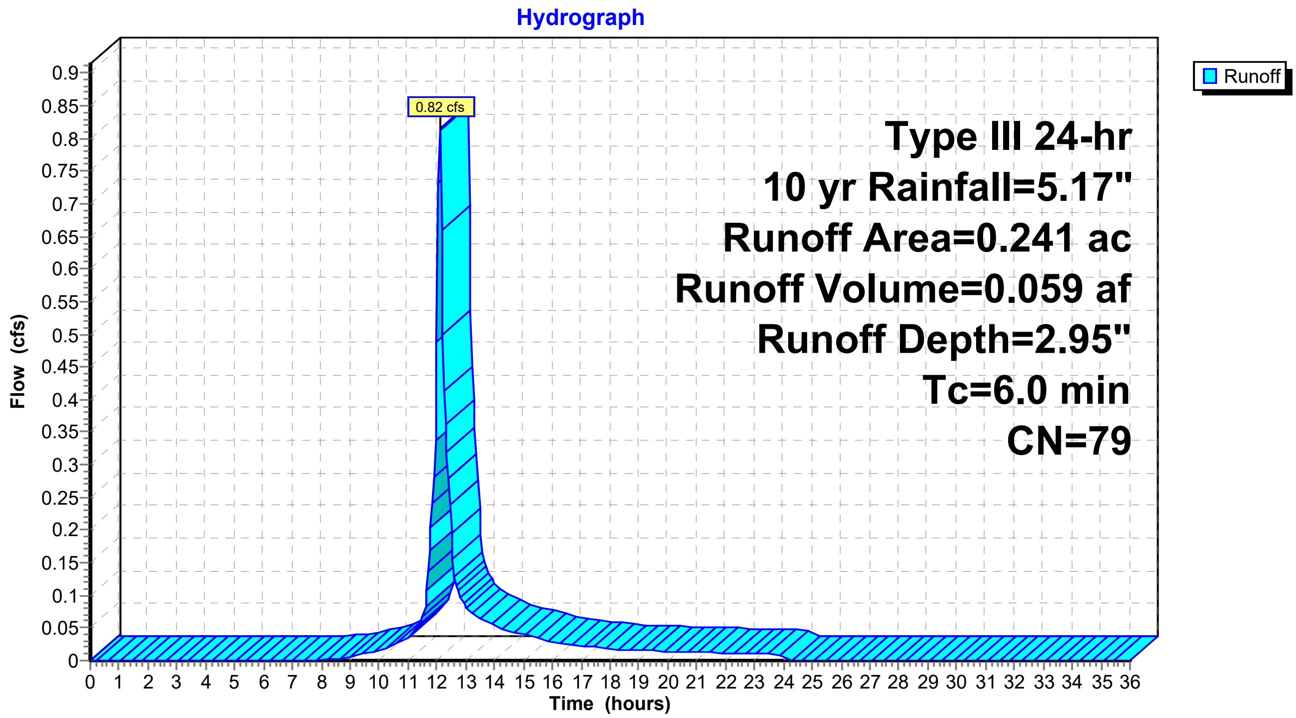
Runoff = 0.82 cfs @ 12.09 hrs, Volume= 0.059 af, Depth= 2.95"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=5.17"

Area (ac)	CN	Description
0.124	61	>75% Grass cover, Good, HSG B
0.117	98	Paved parking, HSG B
0.241	79	Weighted Average
0.124		51.45% Pervious Area
0.117		48.55% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-3B: PR-3B



Summary for Subcatchment PR-3C: PR-3C

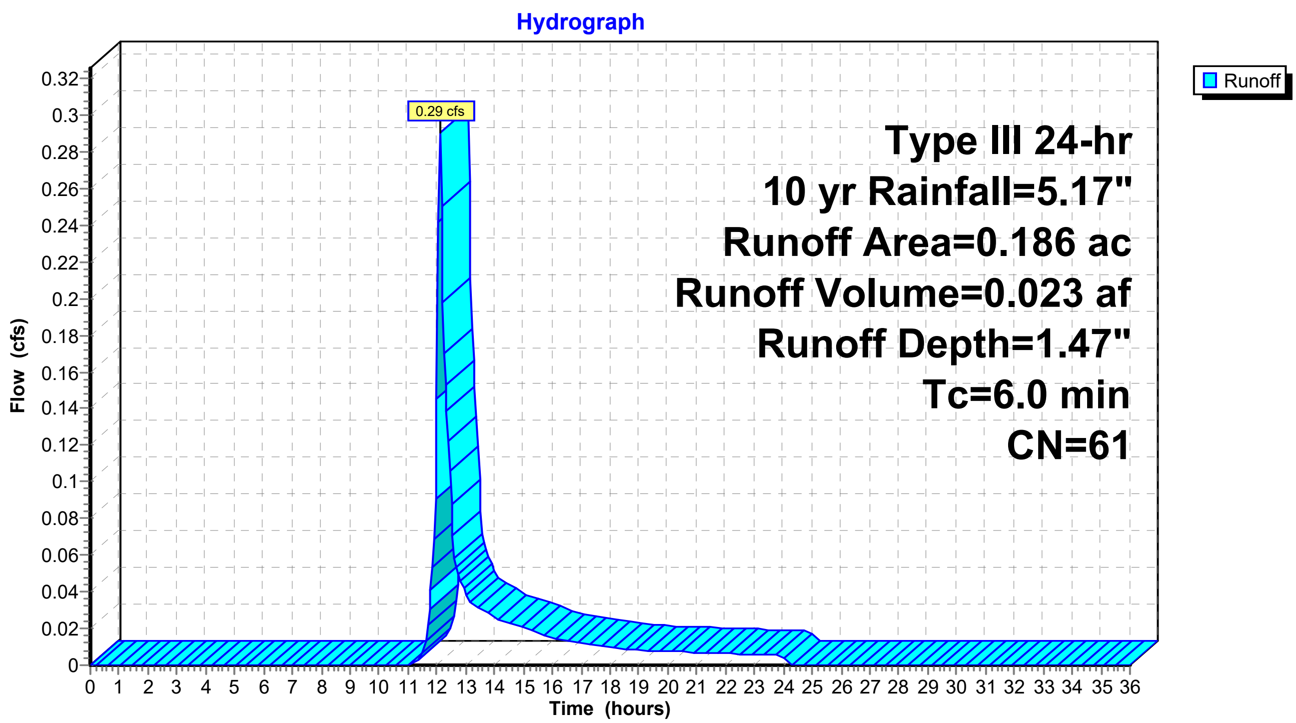
Runoff = 0.29 cfs @ 12.10 hrs, Volume= 0.023 af, Depth= 1.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=5.17"

Area (ac)	CN	Description
0.186	61	>75% Grass cover, Good, HSG B
0.186		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-3C: PR-3C



Summary for Subcatchment PR-4A: SB 01 A

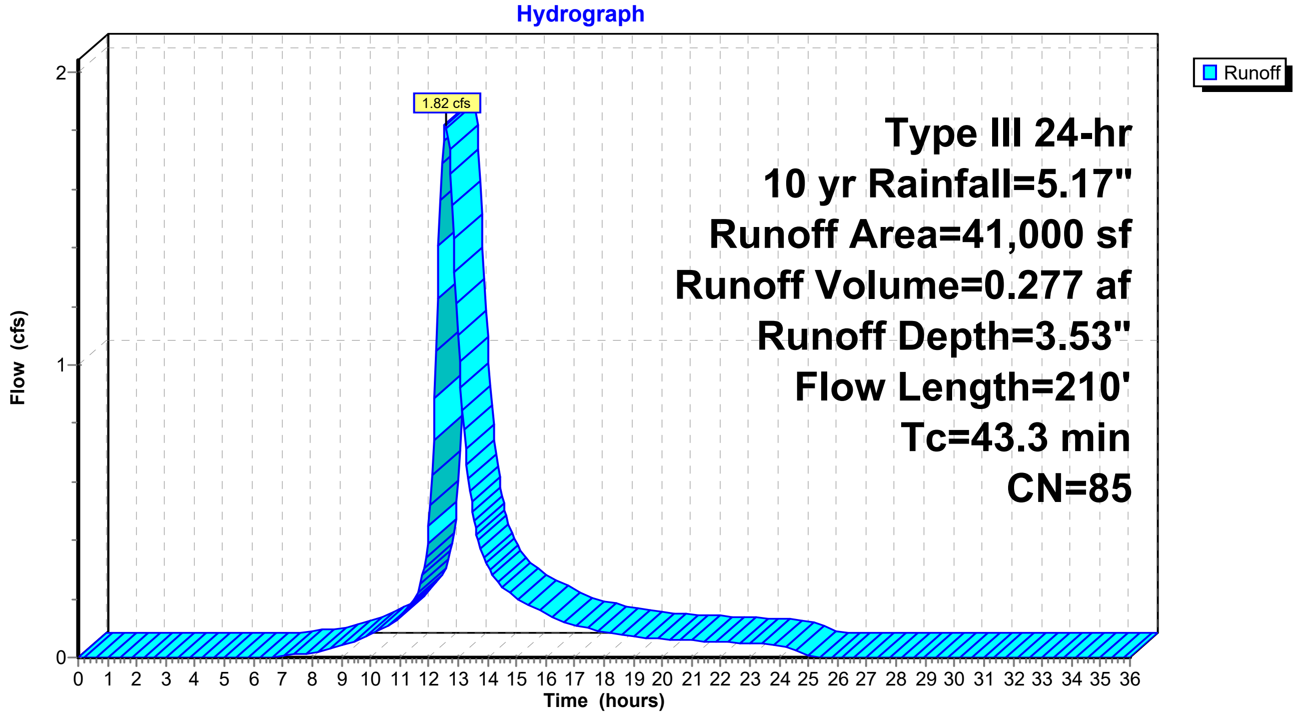
Runoff = 1.82 cfs @ 12.58 hrs, Volume= 0.277 af, Depth= 3.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=5.17"

	Area (sf)	CN	Description
*	41,000	85	SYNTHETIC TURF- PAD- LINER
	41,000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
39.6	110	0.0055	0.05		**Sheet Flow, Through Turf Section** Grass: Bermuda n= 0.410 P2= 3.20"
3.7	100	0.0001	0.45	0.16	**Pipe Channel, TRENCH DRAIN LEVEL** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010
43.3	210	Total			

Subcatchment PR-4A: SB 01 A



Summary for Subcatchment PR-4B: SB 11 A

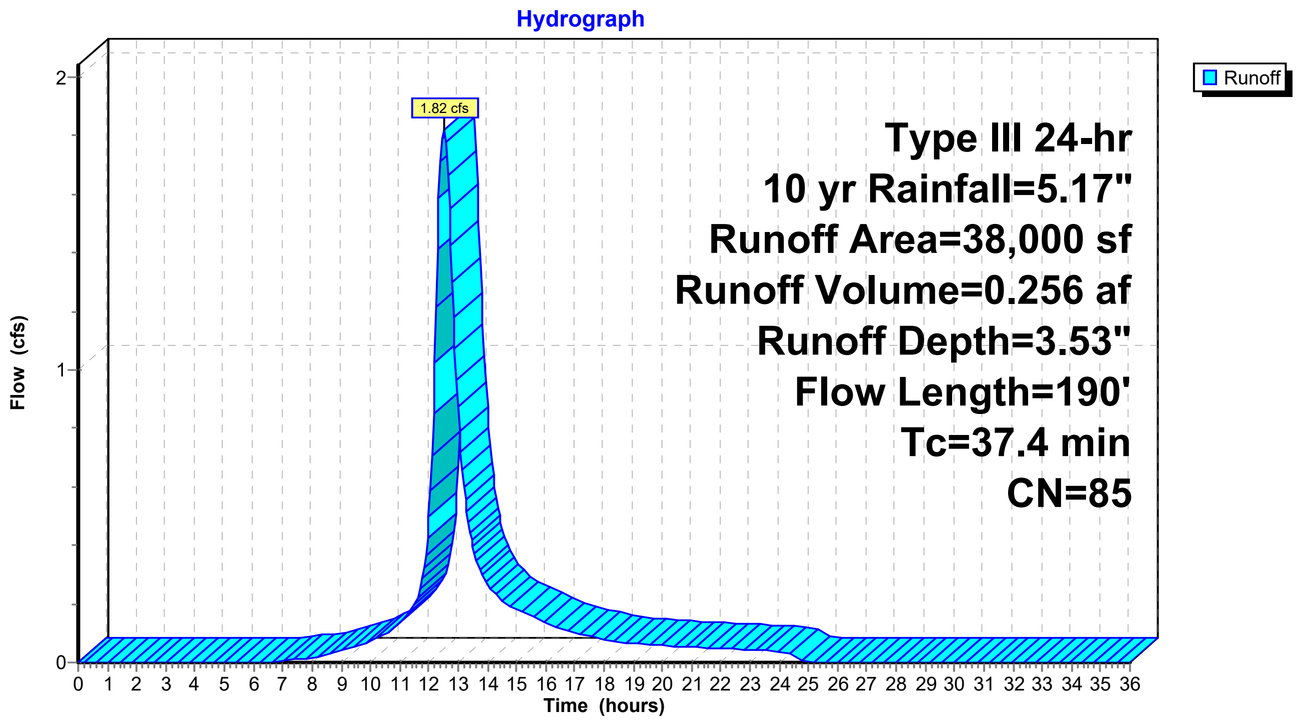
Runoff = 1.82 cfs @ 12.51 hrs, Volume= 0.256 af, Depth= 3.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=5.17"

	Area (sf)	CN	Description
*	38,000	85	SYNTHETIC TURF- PAD- LINER
	38,000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
33.7	90	0.0055	0.04		**Sheet Flow, Through Turf Section** Grass: Bermuda n= 0.410 P2= 3.20"
3.7	100	0.0001	0.45	0.16	**Pipe Channel, TRENCH DRAIN LEVEL** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010
37.4	190	Total			

Subcatchment PR-4B: SB 11 A



Summary for Subcatchment PR-4C: SB 00 DPW SLOPE

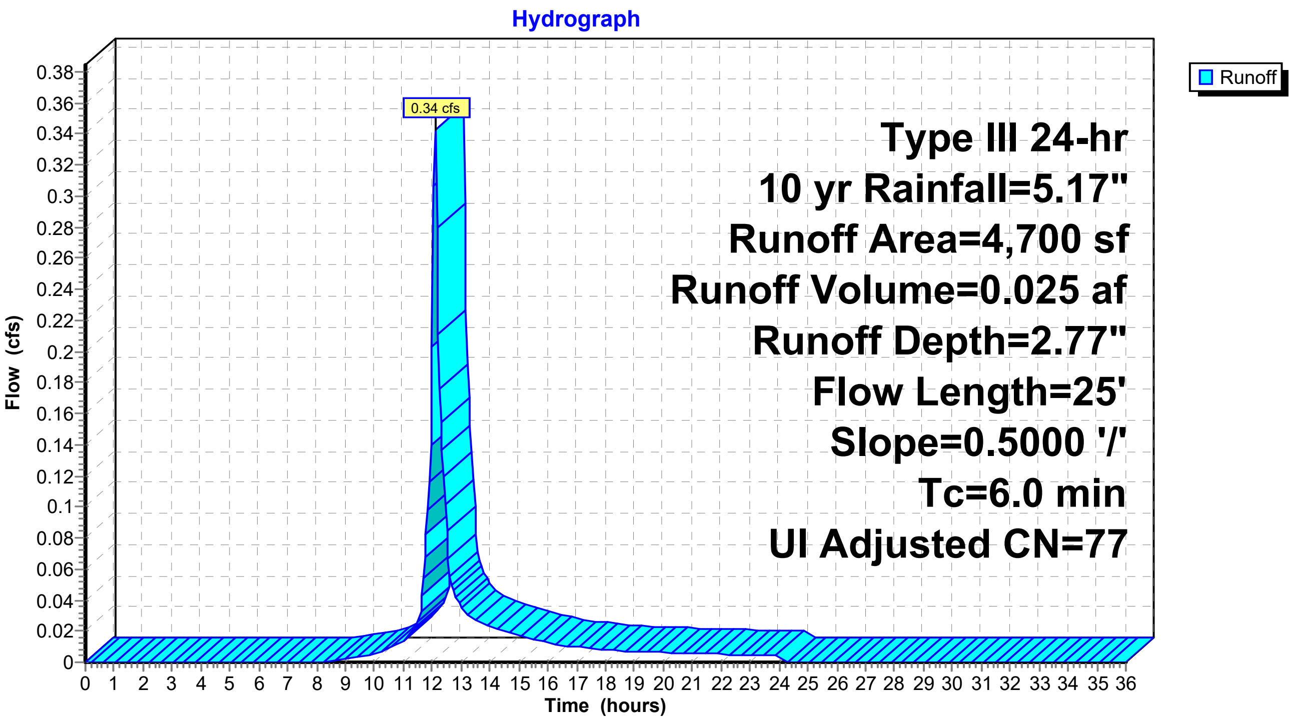
Runoff = 0.34 cfs @ 12.09 hrs, Volume= 0.025 af, Depth= 2.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=5.17"

Area (sf)	CN	Adj	Description
1,100	98		Unconnected pavement, HSG A
3,600	74		>75% Grass cover, Good, HSG C
4,700	80	77	Weighted Average, UI Adjusted
3,600			76.60% Pervious Area
1,100			23.40% Impervious Area
1,100			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.3	25	0.5000	0.32		**Sheet Flow, SLOPING LAND** Grass: Dense n= 0.240 P2= 3.20"
1.3	25	Total, Increased to minimum Tc = 6.0 min			

Subcatchment PR-4C: SB 00 DPW SLOPE



Summary for Subcatchment PR-5A: BB 01 A

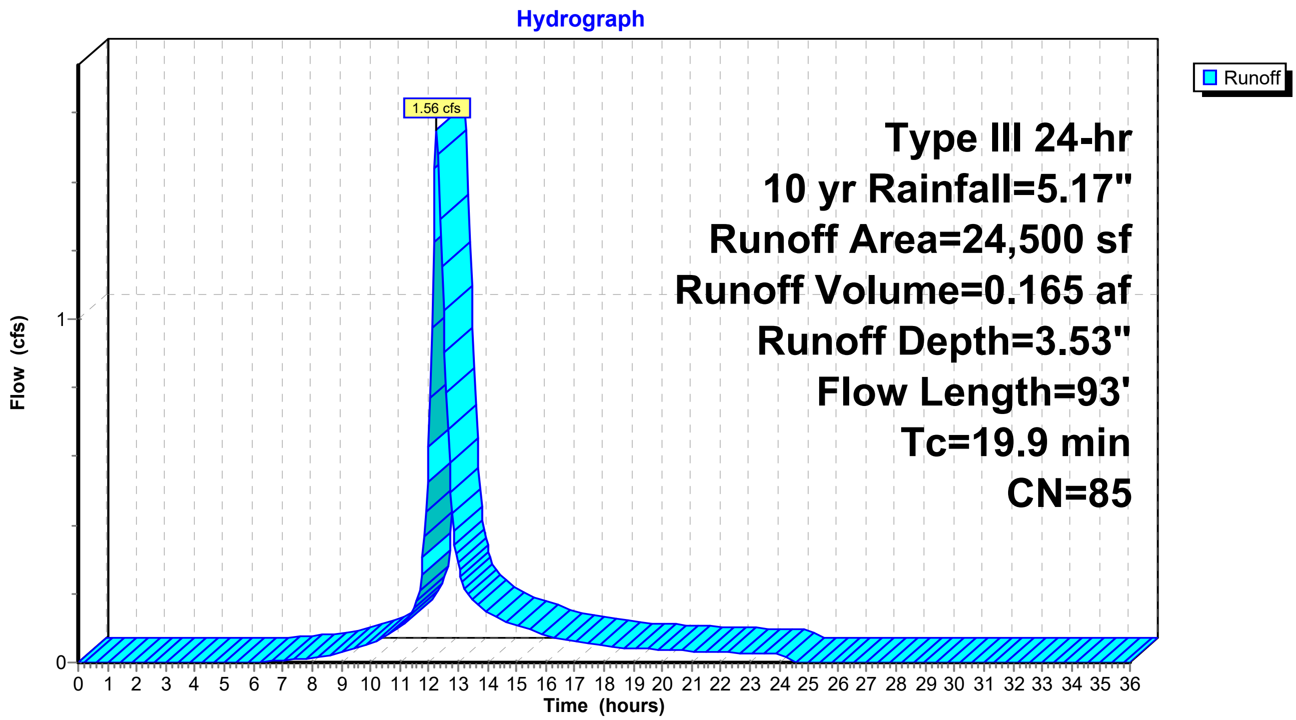
Runoff = 1.56 cfs @ 12.27 hrs, Volume= 0.165 af, Depth= 3.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=5.17"

	Area (sf)	CN	Description
*	24,500	85	SYNTHETIC TURF- PAD- LINER
	24,500		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.2	46	0.0067	0.04		**Sheet Flow, Through Turf Section** Grass: Bermuda n= 0.410 P2= 3.20"
1.7	47	0.0001	0.45	0.16	**Pipe Channel, TRENCH DRAIN LEVEL** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010
19.9	93	Total			

Subcatchment PR-5A: BB 01 A



Summary for Subcatchment PR-5B: BB 11 A

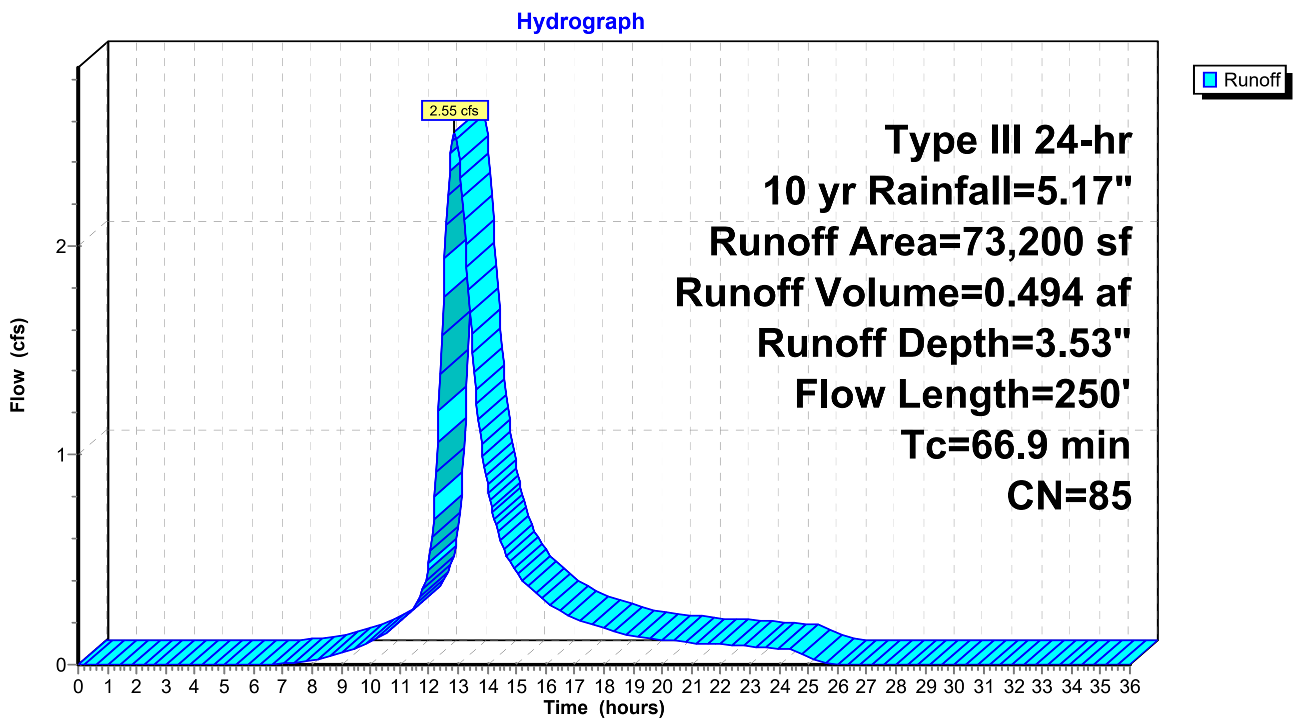
Runoff = 2.55 cfs @ 12.87 hrs, Volume= 0.494 af, Depth= 3.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=5.17"

	Area (sf)	CN	Description
*	73,200	85	SYNTHETIC TURF- PAD- LINER
	73,200		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.1	53	0.0055	0.04		**Sheet Flow, Through Turf Section** Grass: Bermuda n= 0.410 P2= 3.20"
43.1	150	0.0083	0.06		**Sheet Flow, SYNTHETIC TURF** Grass: Bermuda n= 0.410 P2= 3.20"
1.7	47	0.0001	0.45	0.16	**Pipe Channel, TRENCH DRAIN LEVEL** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010
66.9	250	Total			

Subcatchment PR-5B: BB 11 A



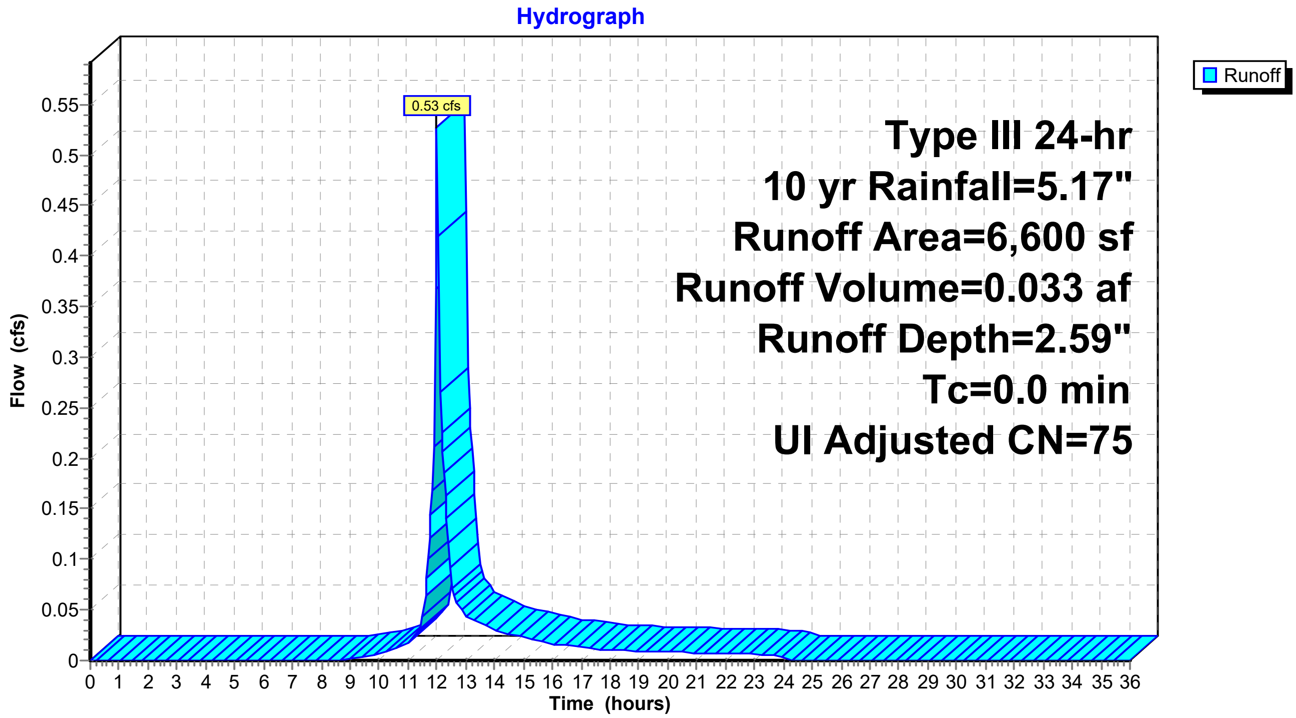
Summary for Subcatchment PR-5C: SLOPE

Runoff = 0.53 cfs @ 12.00 hrs, Volume= 0.033 af, Depth= 2.59"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=5.17"

Area (sf)	CN	Adj	Description
600	98		Unconnected roofs, HSG C
6,000	74		>75% Grass cover, Good, HSG C
6,600	76	75	Weighted Average, UI Adjusted
6,000			90.91% Pervious Area
600			9.09% Impervious Area
600			100.00% Unconnected

Subcatchment PR-5C: SLOPE



Summary for Pond 2P: rain garden#2 cascading

Inflow Area = 0.966 ac, 61.39% Impervious, Inflow Depth > 3.33" for 10 yr event
Inflow = 3.72 cfs @ 12.09 hrs, Volume= 0.268 af
Outflow = 3.71 cfs @ 12.10 hrs, Volume= 0.251 af, Atten= 0%, Lag= 0.5 min
Primary = 0.03 cfs @ 12.10 hrs, Volume= 0.047 af
Secondary = 3.69 cfs @ 12.10 hrs, Volume= 0.204 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 54.65' @ 12.10 hrs Surf.Area= 1,107 sf Storage= 1,363 cf
Flood Elev= 55.00' Surf.Area= 1,326 sf Storage= 1,784 cf

Plug-Flow detention time= 109.2 min calculated for 0.251 af (94% of inflow)
Center-of-Mass det. time= 61.3 min (913.4 - 852.0)

Volume	Invert	Avail.Storage	Storage Description
#1	51.00'	1,557 cf	**Rain Garden Envelope (Prismatic)** Listed below (Recalc) 2,357 cf Overall - 800 cf Embedded = 1,557 cf
#2	51.00'	80 cf	**crush stone (Prismatic)** Listed below (Recalc) Inside #1 200 cf Overall x 40.0% Voids
#3	51.50'	133 cf	**Bio Media (Prismatic)** Listed below (Recalc) Inside #1 532 cf Overall x 25.0% Voids
#4	52.83'	14 cf	**Mulch (Prismatic)** Listed below (Recalc) Inside #1 68 cf Overall x 20.0% Voids
		1,784 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
51.00	400	0	0
53.00	400	800	800
54.00	694	547	1,347
55.00	1,326	1,010	2,357

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
51.00	400	0	0
51.50	400	200	200

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
51.50	400	0	0
52.83	400	532	532

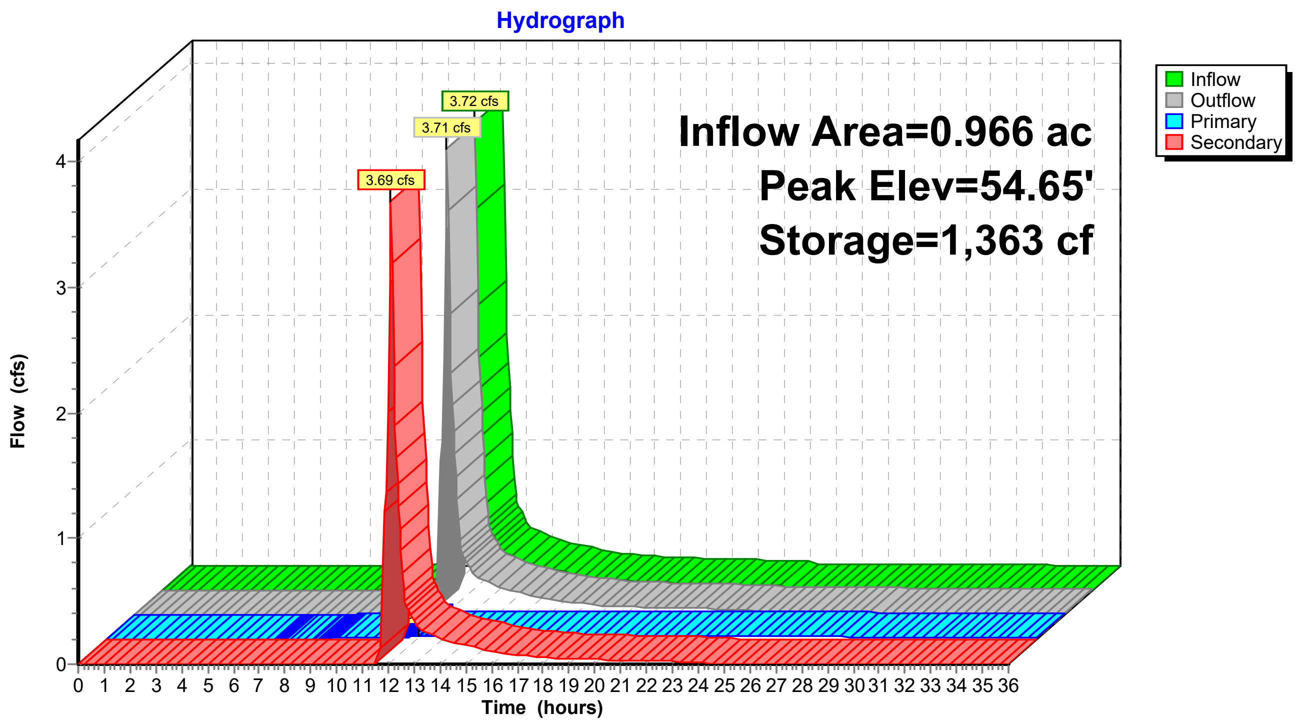
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
52.83	400	0	0
53.00	400	68	68

Device	Routing	Invert	Outlet Devices
#1	Device 3	51.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Secondary	54.50'	**25.0' long x 3.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32
#3	Primary	51.00'	**12.0" Round Culvert** L= 25.0' Ke= 0.500 Inlet / Outlet Invert= 51.00' / 50.88' S= 0.0048 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf

Primary OutFlow Max=0.03 cfs @ 12.10 hrs HW=54.65' TW=49.97' (Dynamic Tailwater)
└─**3=Culvert** (Passes 0.03 cfs of 6.71 cfs potential flow)
  └─**1=Exfiltration** (Exfiltration Controls 0.03 cfs)

Secondary OutFlow Max=3.65 cfs @ 12.10 hrs HW=54.65' TW=49.97' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir** (Weir Controls 3.65 cfs @ 0.95 fps)

Pond 2P: rain garden#2 cascading



Summary for Pond 3P: rain garden#3 cascading

Inflow Area = 1.152 ac, 51.48% Impervious, Inflow Depth > 2.86" for 10 yr event
Inflow = 4.00 cfs @ 12.10 hrs, Volume= 0.274 af
Outflow = 3.80 cfs @ 12.17 hrs, Volume= 0.233 af, Atten= 5%, Lag= 3.8 min
Primary = 3.80 cfs @ 12.17 hrs, Volume= 0.233 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 50.22' @ 12.17 hrs Surf.Area= 1,517 sf Storage= 2,605 cf
Flood Elev= 50.00' Surf.Area= 1,373 sf Storage= 2,283 cf

Plug-Flow detention time= 197.8 min calculated for 0.233 af (85% of inflow)
Center-of-Mass det. time= 88.1 min (997.8 - 909.8)

Volume	Invert	Avail.Storage	Storage Description
#1	46.00'	2,710 cf	**Rain Garden Envelope (Prismatic)**Listed below (Recalc) 3,911 cf Overall - 1,200 cf Embedded = 2,710 cf
#2	46.00'	120 cf	**crush stone (Prismatic)**Listed below (Recalc) Inside #1 300 cf Overall x 40.0% Voids
#3	46.50'	199 cf	**Bio Media (Prismatic)**Listed below (Recalc) Inside #1 798 cf Overall x 25.0% Voids
#4	47.83'	20 cf	**Mulch (Prismatic)**Listed below (Recalc) Inside #1 102 cf Overall x 20.0% Voids
		3,050 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
46.00	600	0	0
48.00	600	1,200	1,200
49.00	957	779	1,979
50.00	1,373	1,165	3,144
50.50	1,695	767	3,911

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
46.00	600	0	0
46.50	600	300	300

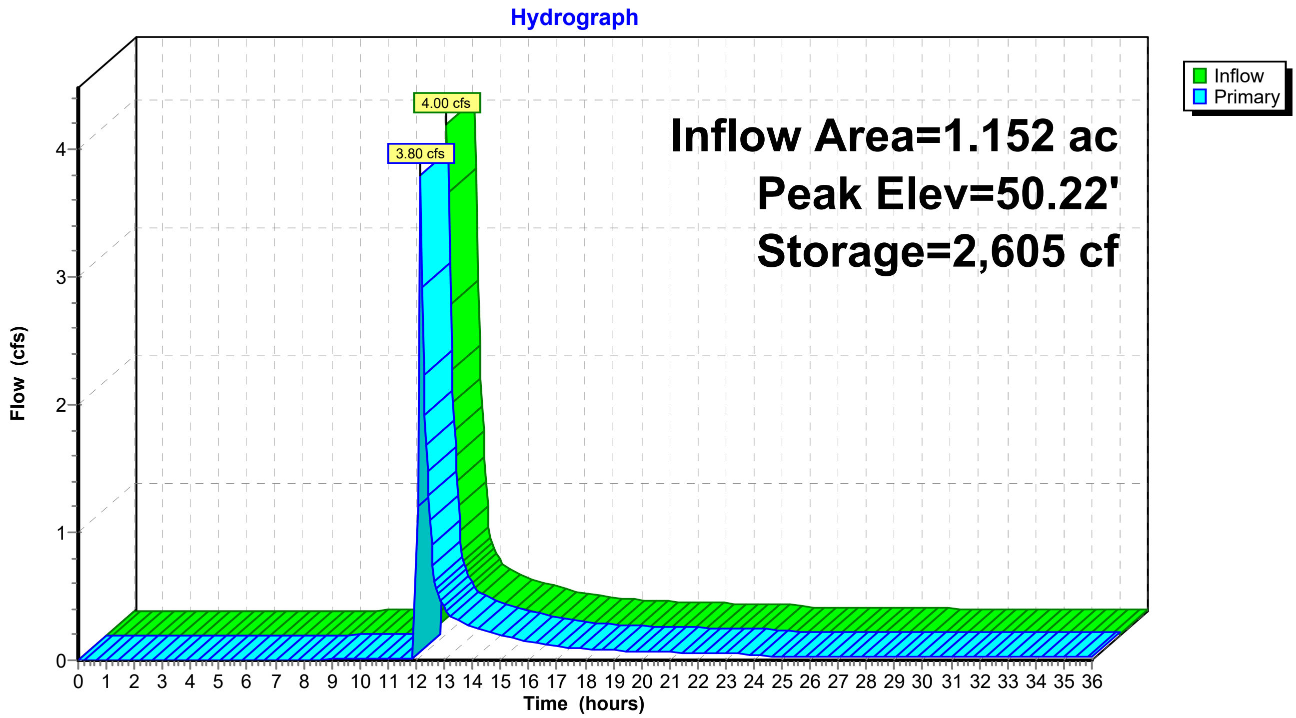
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
46.50	600	0	0
47.83	600	798	798

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
47.83	600	0	0
48.00	600	102	102

Device	Routing	Invert	Outlet Devices
#1	Device 3	46.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Device 3	50.00'	**24.0" x 48.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Primary	46.00'	**15.0" Round Culvert** L= 26.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 46.00' / 45.87' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf

Primary OutFlow Max=3.33 cfs @ 12.17 hrs HW=50.19' TW=0.00' (Dynamic Tailwater)
3=Culvert (Passes 3.33 cfs of 8.81 cfs potential flow)
1=Exfiltration (Exfiltration Controls 0.04 cfs)
2=Orifice/Grate (Weir Controls 3.29 cfs @ 1.43 fps)

Pond 3P: rain garden#3 cascading



Summary for Pond 4P: UGS-1

Inflow Area = 1.705 ac, 60.59% Impervious, Inflow Depth = 3.42" for 10 yr event
Inflow = 6.48 cfs @ 12.09 hrs, Volume= 0.485 af
Outflow = 6.85 cfs @ 12.11 hrs, Volume= 0.448 af, Atten= 0%, Lag= 1.0 min
Discarded = 0.04 cfs @ 8.55 hrs, Volume= 0.100 af
Primary = 6.81 cfs @ 12.11 hrs, Volume= 0.347 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 43.93' @ 12.11 hrs Surf.Area= 1,672 sf Storage= 4,668 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 118.5 min (920.4 - 801.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	39.50'	2,099 cf	**29.92'W x 55.89'L x 5.50'H Field A** 9,196 cf Overall - 3,198 cf Embedded = 5,998 cf x 35.0% Voids
#2A	40.25'	3,198 cf	**ADS_StormTech MC-3500 d +Cap** x 28 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap 28 Chambers in 4 Rows Cap Storage= +14.9 cf x 2 x 4 rows = 119.2 cf
		5,297 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	39.25'	**24.0" Round Culvert** L= 50.0' Ke= 0.500 Inlet / Outlet Invert= 39.25' / 38.75' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf
#2	Device 1	43.67'	**5.0' long x 4.00' rise Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Discarded	39.50'	**1.020 in/hr Exfiltration over Surface area**
#4	Device 1	42.42'	**9.0" Vert. Orifice/Grate** X 3 rows with 6.0" cc spacing C= 0.600

Discarded OutFlow Max=0.04 cfs @ 8.55 hrs HW=39.58' (Free Discharge)
└─**3=Exfiltration** (Exfiltration Controls 0.04 cfs)

Primary OutFlow Max=6.56 cfs @ 12.11 hrs HW=43.91' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Passes 6.56 cfs of 28.94 cfs potential flow)
  ├─**2=Sharp-Crested Rectangular Weir** (Weir Controls 1.91 cfs @ 1.60 fps)
  └─**4=Orifice/Grate** (Orifice Controls 4.65 cfs @ 3.90 fps)

Pond 4P: UGS-1 - Chamber Wizard Field A

Chamber Model = ADS_StormTechMC-3500 d +Cap (ADS StormTech®MC-3500 d rev 03/14 with Cap volume)
Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf
Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap
Cap Storage= +14.9 cf x 2 x 4 rows = 119.2 cf

77.0" Wide + 9.0" Spacing = 86.0" C-C Row Spacing

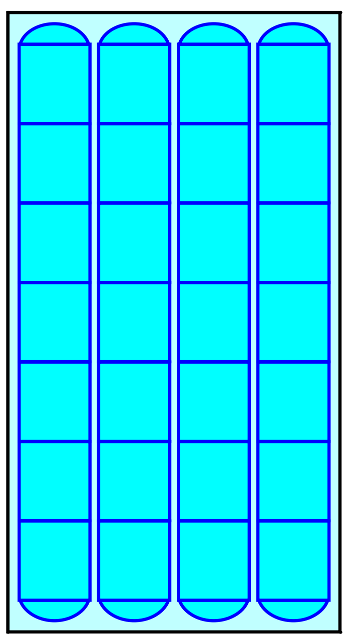
7 Chambers/Row x 7.17' Long +1.85' Cap Length x 2 = 53.89' Row Length +12.0" End Stone x 2 = 55.89' Base Length
4 Rows x 77.0" Wide + 9.0" Spacing x 3 + 12.0" Side Stone x 2 = 29.92' Base Width
9.0" Base + 45.0" Chamber Height + 12.0" Cover = 5.50' Field Height

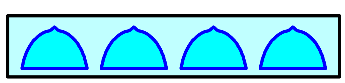
28 Chambers x 110.0 cf + 14.9 cf Cap Volume x 2 x 4 Rows = 3,197.9 cf Chamber Storage

9,196.2 cf Field - 3,197.9 cf Chambers = 5,998.4 cf Stone x 35.0% Voids = 2,099.4 cf Stone Storage

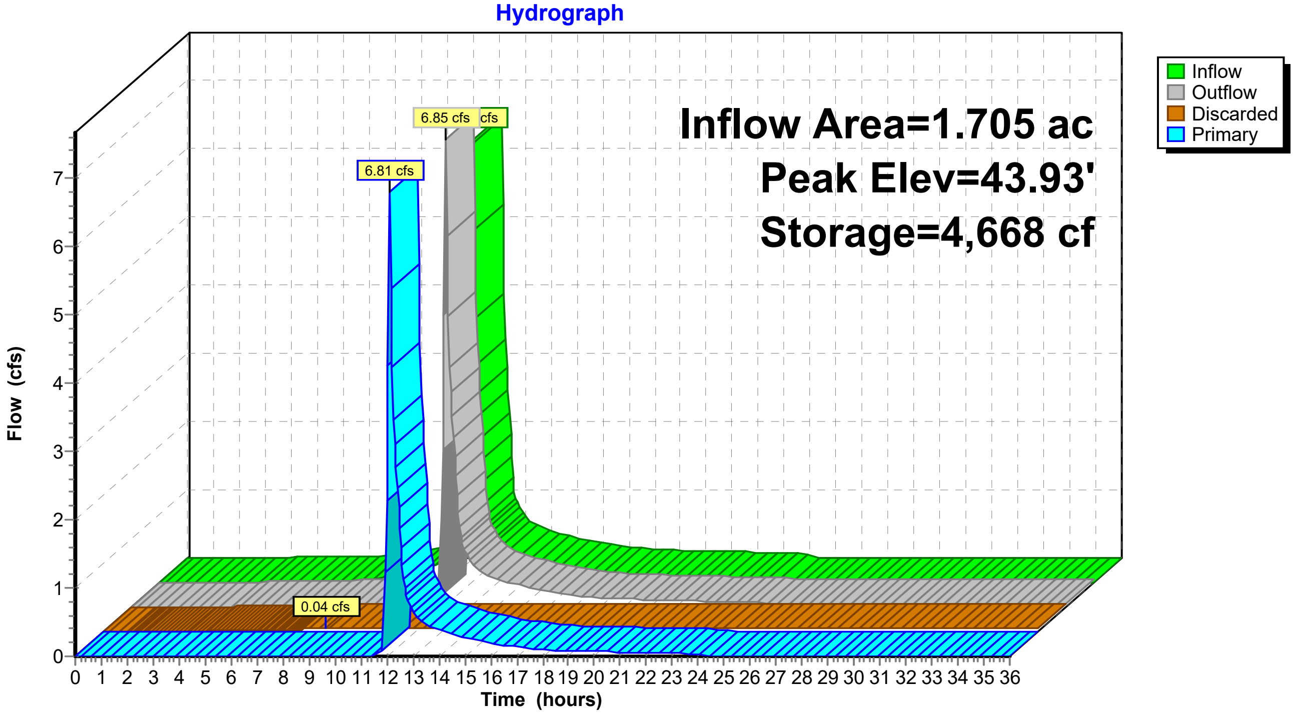
Chamber Storage + Stone Storage = 5,297.3 cf = 0.122 af
Overall Storage Efficiency = 57.6%
Overall System Size = 55.89' x 29.92' x 5.50'

28 Chambers
340.6 cy Field
222.2 cy Stone





Pond 4P: UGS-1


Hydrograph
Inflow
Outflow
Discarded
Primary
Inflow Area=1.705 ac
Peak Elev=43.93'
Storage=4,668 cf
6.85 cfs
6.81 cfs
0.04 cfs
Flow (cfs)
Time (hours)
0
1
2
3
4
5
6
7
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36

Summary for Pond 5P: rain garden#1 cascading

Inflow Area = 0.725 ac, 65.66% Impervious, Inflow Depth = 3.53" for 10 yr event
Inflow = 2.90 cfs @ 12.09 hrs, Volume= 0.213 af
Outflow = 2.91 cfs @ 12.10 hrs, Volume= 0.209 af, Atten= 0%, Lag= 0.3 min
Primary = 0.01 cfs @ 12.10 hrs, Volume= 0.024 af
Secondary = 2.89 cfs @ 12.10 hrs, Volume= 0.185 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 62.13' @ 12.10 hrs Surf.Area= 524 sf Storage= 618 cf
Flood Elev= 63.00' Surf.Area= 660 sf Storage= 1,132 cf

Plug-Flow detention time= 65.7 min calculated for 0.209 af (98% of inflow)
Center-of-Mass det. time= 54.0 min (860.3 - 806.2)

Volume	Invert	Avail.Storage	Storage Description
#1	58.50'	1,048 cf	**Rain Garden Envelope (Prismatic)**Listed below (Recalc) 1,348 cf Overall - 300 cf Embedded = 1,048 cf
#2	58.50'	30 cf	**crush stone (Prismatic)**Listed below (Recalc) Inside #1 75 cf Overall x 40.0% Voids
#3	59.00'	50 cf	**Bio Media (Prismatic)**Listed below (Recalc) Inside #1 199 cf Overall x 25.0% Voids
#4	60.33'	5 cf	**Mulch (Prismatic)**Listed below (Recalc) Inside #1 26 cf Overall x 20.0% Voids
		1,132 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
58.50	150	0	0
60.50	150	300	300
61.00	236	97	397
62.00	503	370	766
63.00	660	582	1,348

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
58.50	150	0	0
59.00	150	75	75

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
59.00	150	0	0
60.33	150	199	199

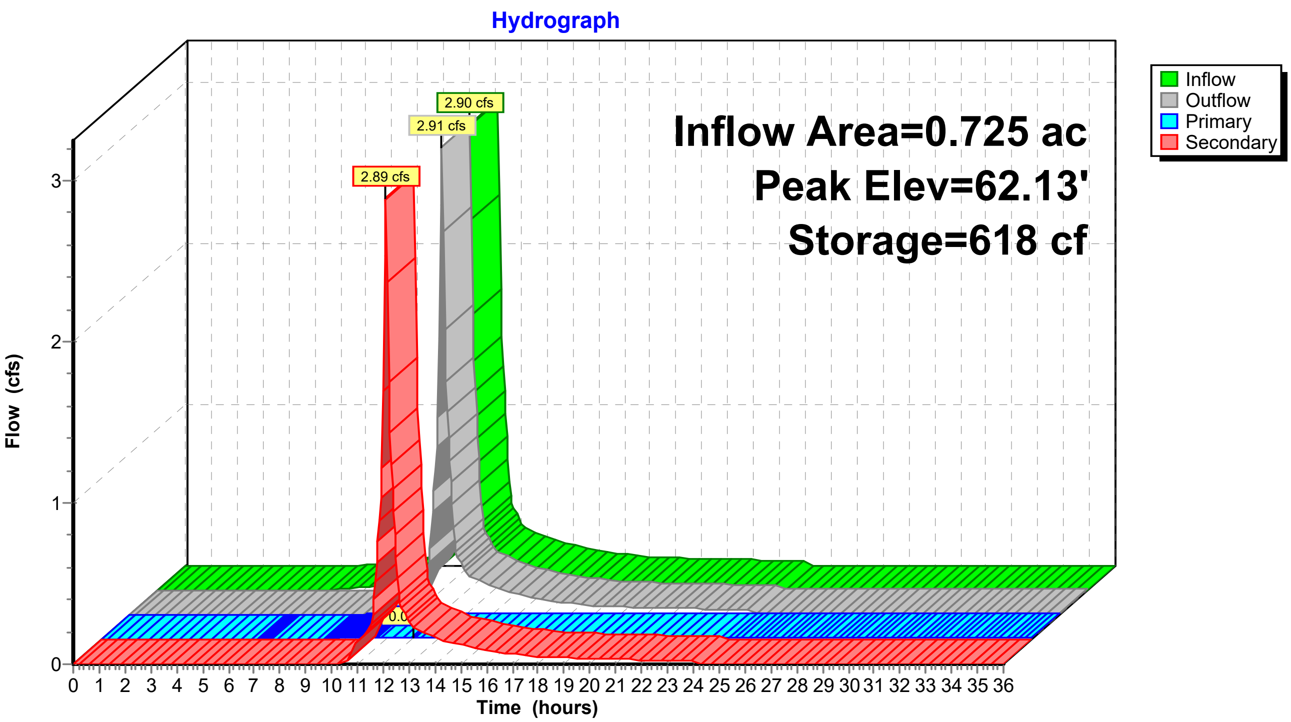
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
60.33	150	0	0
60.50	150	26	26

Device	Routing	Invert	Outlet Devices
#1	Device 3	58.50'	**1.020 in/hr Exfiltration over Surface area**
#2	Secondary	62.00'	**25.0' long x 3.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32
#3	Primary	58.50'	**8.0" Round Culvert** L= 20.0' Ke= 0.500 Inlet / Outlet Invert= 58.50' / 58.40' S= 0.0050 '/' Cc= 0.900 n= 0.012, Flow Area= 0.35 sf

Primary OutFlow Max=0.01 cfs @ 12.10 hrs HW=62.13' TW=54.65' (Dynamic Tailwater)
↑—**3=Culvert** (Passes 0.01 cfs of 3.05 cfs potential flow)
↑—**1=Exfiltration** (Exfiltration Controls 0.01 cfs)

Secondary OutFlow Max=2.86 cfs @ 12.10 hrs HW=62.13' TW=54.65' (Dynamic Tailwater)
↑—**2=Broad-Crested Rectangular Weir** (Weir Controls 2.86 cfs @ 0.88 fps)

Pond 5P: rain garden#1 cascading



Summary for Pond BB 01 B: BB 01 B

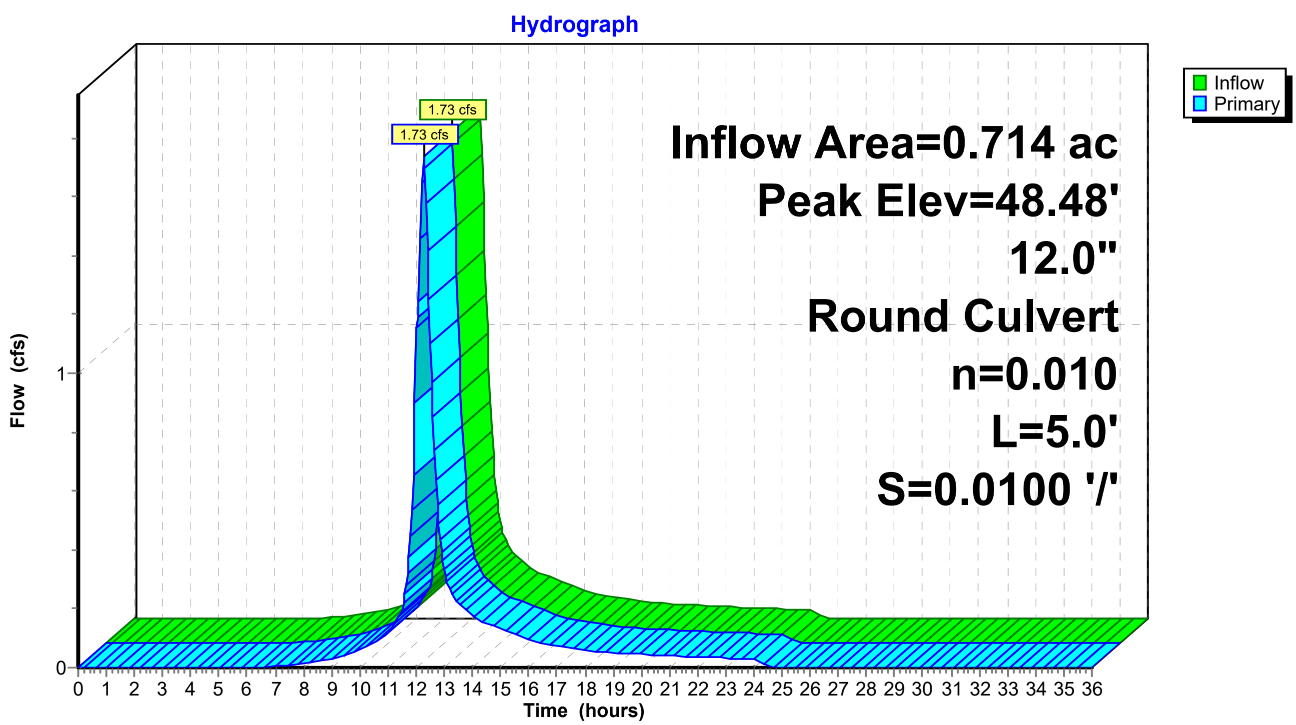
Inflow Area = 0.714 ac, 1.93% Impervious, Inflow Depth = 3.33" for 10 yr event
Inflow = 1.73 cfs @ 12.26 hrs, Volume= 0.198 af
Outflow = 1.73 cfs @ 12.26 hrs, Volume= 0.198 af, Atten= 0%, Lag= 0.0 min
Primary = 1.73 cfs @ 12.26 hrs, Volume= 0.198 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 48.48' @ 12.26 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	47.63'	**12.0" Round Culvert** L= 5.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 47.63' / 47.58' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=1.72 cfs @ 12.26 hrs HW=48.48' TW=46.74' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 1.72 cfs @ 3.27 fps)

Pond BB 01 B: BB 01 B



Summary for Pond BB 01 S: BB 01 S

Inflow Area = 0.714 ac, 1.93% Impervious, Inflow Depth = 3.33" for 10 yr event
Inflow = 1.73 cfs @ 12.26 hrs, Volume= 0.198 af
Outflow = 0.20 cfs @ 13.66 hrs, Volume= 0.198 af, Atten= 88%, Lag= 84.0 min
Primary = 0.20 cfs @ 13.66 hrs, Volume= 0.198 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 47.04' @ 13.66 hrs Surf.Area= 0 sf Storage= 3,792 cf

Plug-Flow detention time= 194.0 min calculated for 0.198 af (100% of inflow)
Center-of-Mass det. time= 193.6 min (1,014.1 - 820.5)

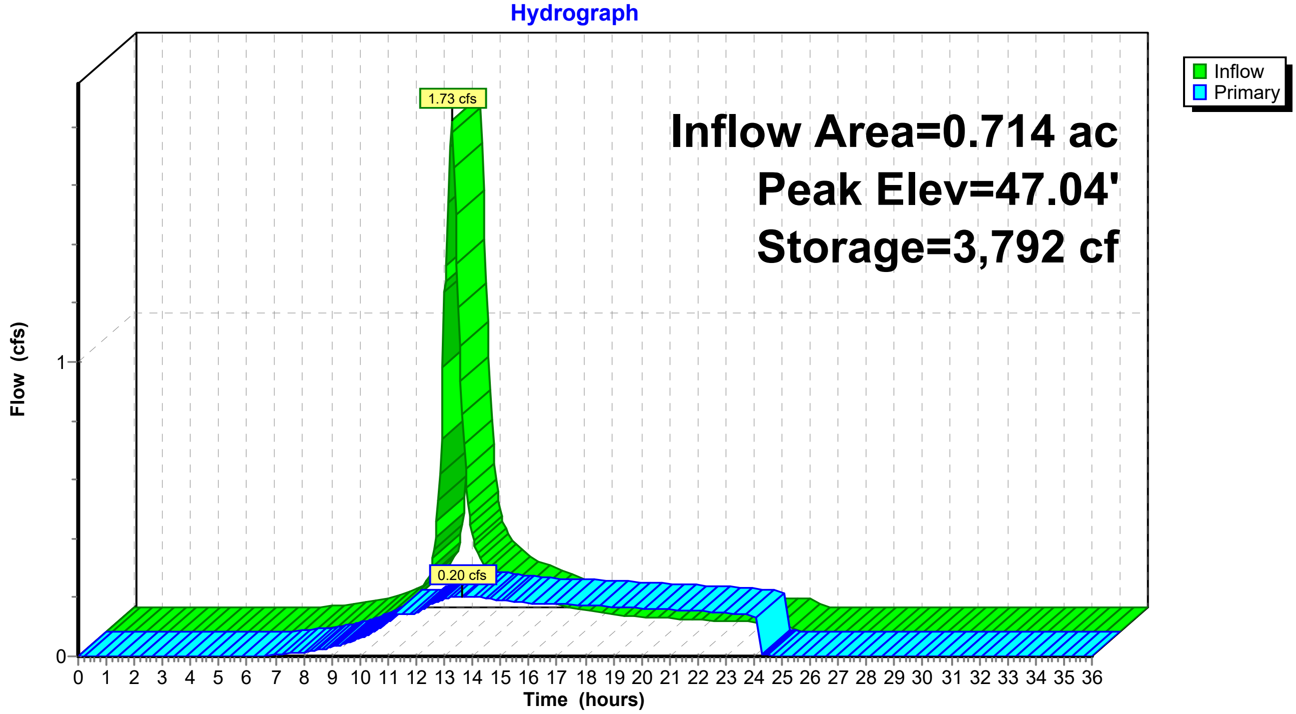
Volume	Invert	Avail.Storage	Storage Description
#1	45.65'	8,017 cf	**Custom Stage Data** Listed below

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
45.65	0	0
46.48	16	16
46.98	3,378	3,394
47.48	3,405	6,799
47.98	1,218	8,017

Device	Routing	Invert	Outlet Devices
#1	Primary	45.65'	**2.5" Vert. Orifice/Grate** C= 0.600
#2	Primary	46.98'	**4.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	46.98'	**5.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.20 cfs @ 13.66 hrs HW=47.04' TW=45.48' (Dynamic Tailwater)
├─**1=Orifice/Grate** (Orifice Controls 0.19 cfs @ 5.46 fps)
├─**2=Orifice/Grate** (Orifice Controls 0.01 cfs @ 0.82 fps)
└─**3=Orifice/Grate** (Orifice Controls 0.01 cfs @ 0.82 fps)

Pond BB 01 S: BB 01 S



Summary for Pond BB 06 B: BB 06 B

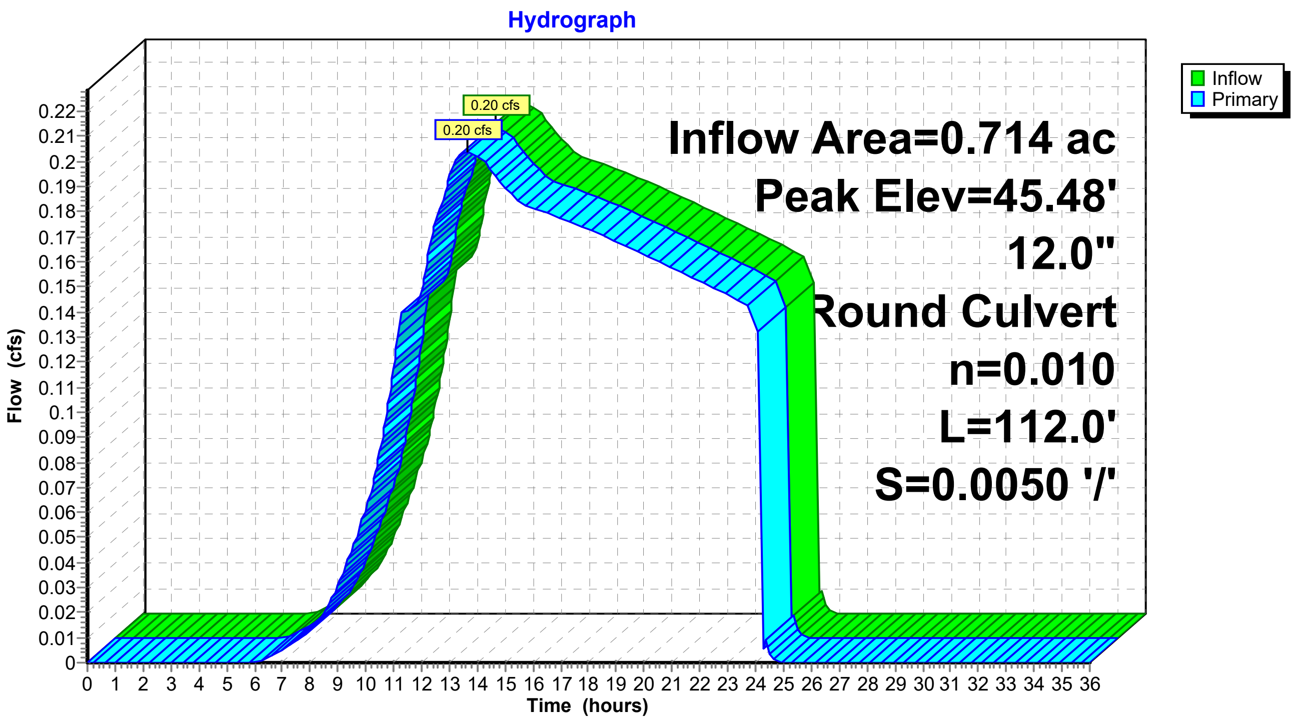
Inflow Area = 0.714 ac, 1.93% Impervious, Inflow Depth = 3.33" for 10 yr event
Inflow = 0.20 cfs @ 13.66 hrs, Volume= 0.198 af
Outflow = 0.20 cfs @ 13.66 hrs, Volume= 0.198 af, Atten= 0%, Lag= 0.0 min
Primary = 0.20 cfs @ 13.66 hrs, Volume= 0.198 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 45.48' @ 13.66 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	45.25'	**12.0" Round Culvert** L= 112.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 45.25' / 44.69' S= 0.0050 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=0.20 cfs @ 13.66 hrs HW=45.48' TW=44.73' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 0.20 cfs @ 2.23 fps)

Pond BB 06 B: BB 06 B



Summary for Pond BB 07 B: BB 07 B

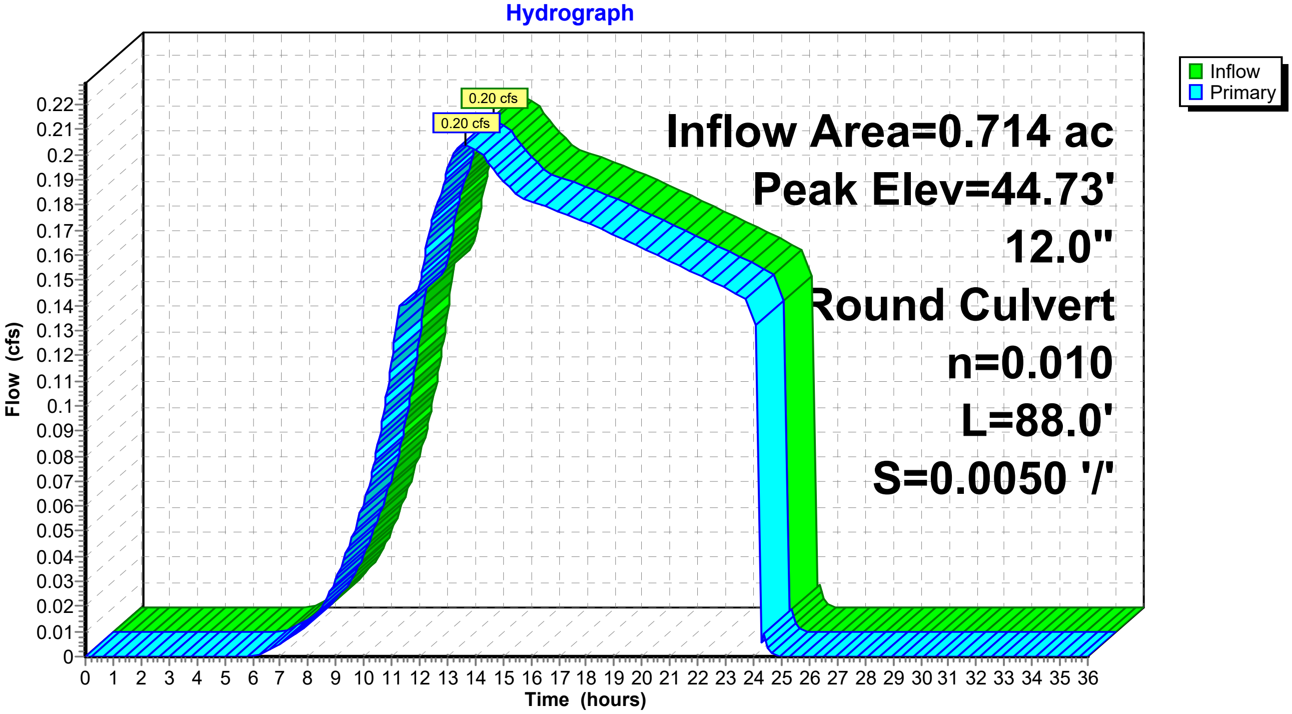
Inflow Area = 0.714 ac, 1.93% Impervious, Inflow Depth = 3.33" for 10 yr event
Inflow = 0.20 cfs @ 13.66 hrs, Volume= 0.198 af
Outflow = 0.20 cfs @ 13.66 hrs, Volume= 0.198 af, Atten= 0%, Lag= 0.0 min
Primary = 0.20 cfs @ 13.66 hrs, Volume= 0.198 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 44.73' @ 13.55 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	44.50'	**12.0" Round Culvert** L= 88.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 44.50' / 44.06' S= 0.0050 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=0.20 cfs @ 13.66 hrs HW=44.73' TW=44.24' (Dynamic Tailwater)
└─**1=Culvert** (Outlet Controls 0.20 cfs @ 2.20 fps)

Pond BB 07 B: BB 07 B



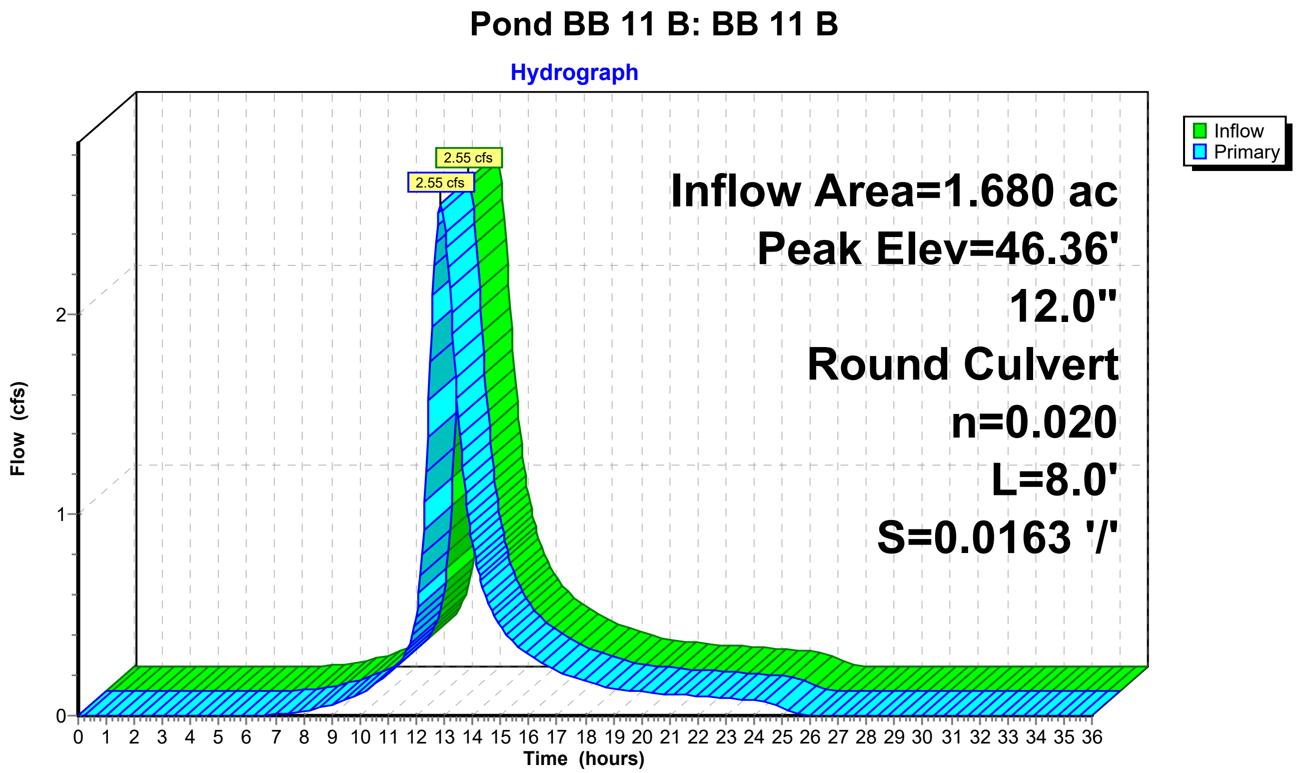
Summary for Pond BB 11 B: BB 11 B

Inflow Area =	1.680 ac,	0.00% Impervious, Inflow Depth =	3.53"	for 10 yr event
Inflow =	2.55 cfs @	12.87 hrs, Volume=	0.494 af	
Outflow =	2.55 cfs @	12.87 hrs, Volume=	0.494 af,	Atten= 0%, Lag= 0.0 min
Primary =	2.55 cfs @	12.87 hrs, Volume=	0.494 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 46.36' @ 12.87 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	45.25'	**12.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 45.25' / 45.12' S= 0.0163 '/' Cc= 0.900 n= 0.020, Flow Area= 0.79 sf

Primary OutFlow Max=2.54 cfs @ 12.87 hrs HW=46.35' TW=45.28' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 2.54 cfs @ 3.65 fps)



Summary for Pond BB 11 S: BB 11 S

Inflow Area = 1.680 ac, 0.00% Impervious, Inflow Depth = 3.53" for 10 yr event
Inflow = 2.55 cfs @ 12.87 hrs, Volume= 0.494 af
Outflow = 1.58 cfs @ 13.45 hrs, Volume= 0.494 af, Atten= 38%, Lag= 34.5 min
Primary = 1.58 cfs @ 13.45 hrs, Volume= 0.494 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 45.49' @ 13.45 hrs Surf.Area= 0 sf Storage= 3,305 cf

Plug-Flow detention time= 15.1 min calculated for 0.493 af (100% of inflow)
Center-of-Mass det. time= 15.1 min (877.7 - 862.7)

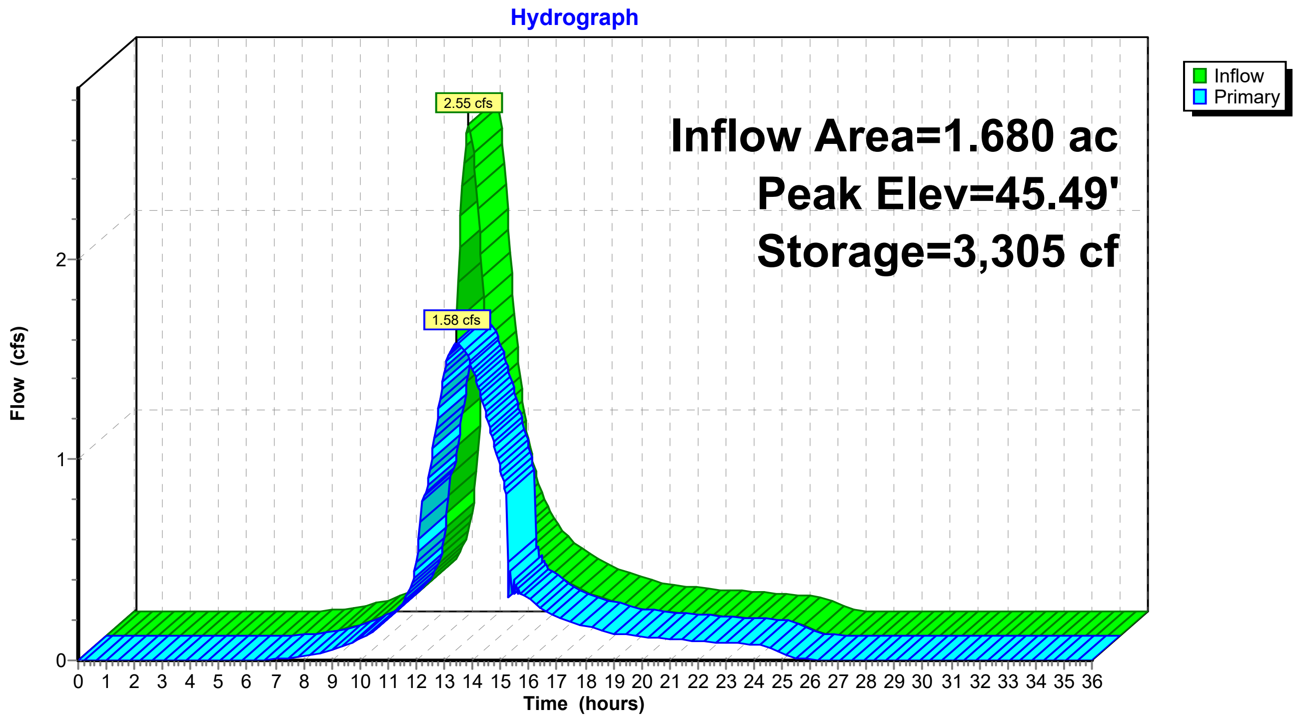
Volume	Invert	Avail.Storage	Storage Description
#1	44.14'	7,432 cf	**Custom Stage Data**Listed below

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
44.14	0	0
44.97	16	16
45.47	3,131	3,147
45.97	3,156	6,303
46.47	1,129	7,432

Device	Routing	Invert	Outlet Devices
#1	Primary	44.14'	**2.5" Vert. Orifice/Grate** C= 0.600
#2	Primary	44.47'	**8.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	45.47'	**6.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=1.58 cfs @ 13.45 hrs HW=45.49' TW=44.25' (Dynamic Tailwater)
1=Orifice/Grate (Orifice Controls 0.18 cfs @ 5.38 fps)
2=Orifice/Grate (Orifice Controls 1.40 cfs @ 4.00 fps)
3=Orifice/Grate (Orifice Controls 0.00 cfs @ 0.54 fps)

Pond BB 11 S: BB 11 S



Summary for Pond PR-4: SB 01 DMH

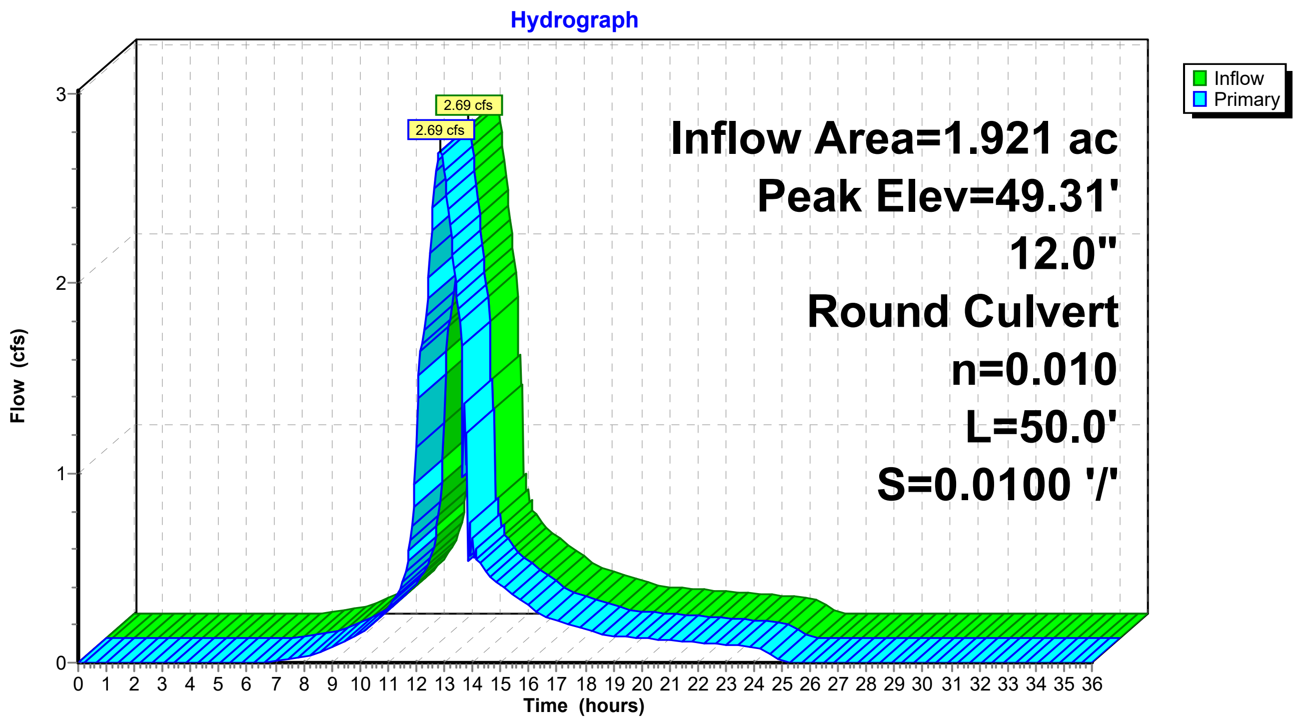
Inflow Area =	1.921 ac,	1.31% Impervious,	Inflow Depth = 3.48"	for 10 yr event	
Inflow =	2.69 cfs @	12.84 hrs,	Volume=	0.558 af	
Outflow =	2.69 cfs @	12.84 hrs,	Volume=	0.558 af,	Atten= 0%, Lag= 0.0 min
Primary =	2.69 cfs @	12.84 hrs,	Volume=	0.558 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 49.31' @ 12.84 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	48.30'	**12.0" Round Culvert** L= 50.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 48.30' / 47.80' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=2.69 cfs @ 12.84 hrs HW=49.31' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 2.69 cfs @ 3.43 fps)

Pond PR-4: SB 01 DMH



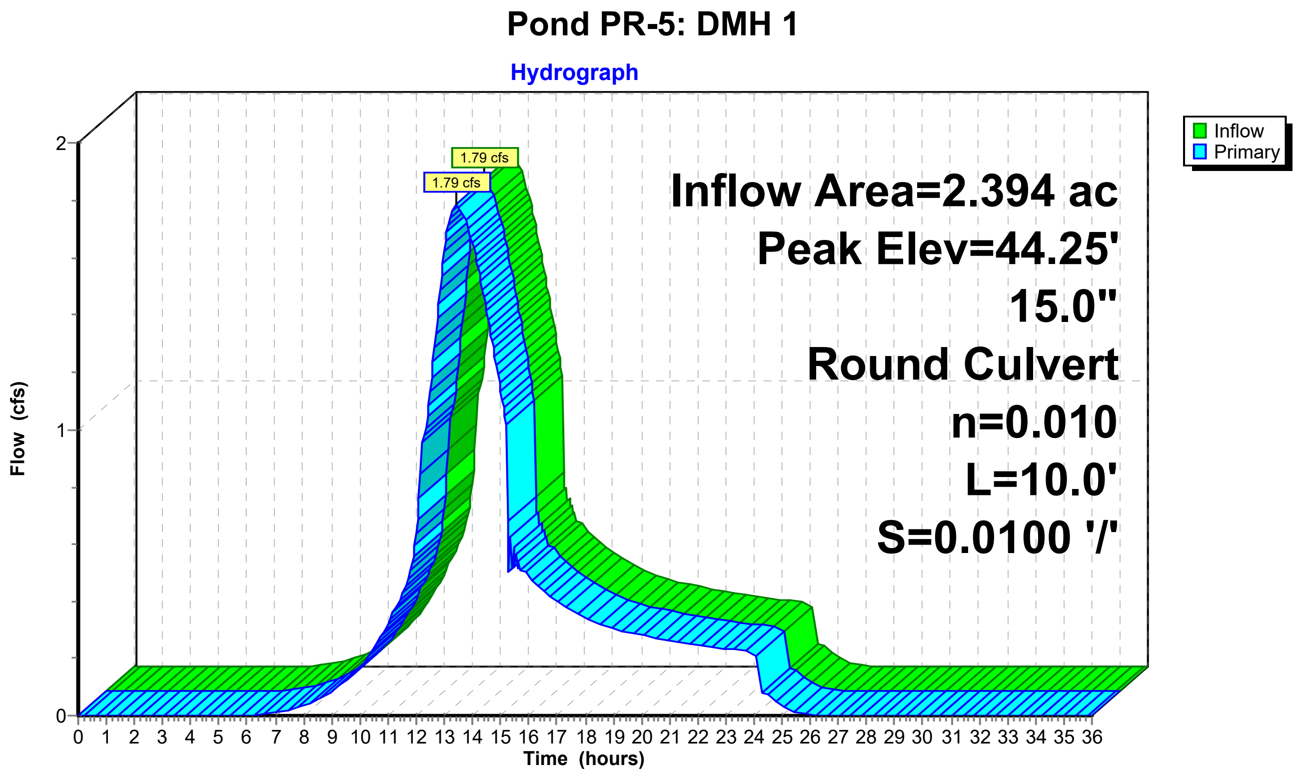
Summary for Pond PR-5: DMH 1

Inflow Area = 2.394 ac, 0.58% Impervious, Inflow Depth = 3.47" for 10 yr event
Inflow = 1.79 cfs @ 13.45 hrs, Volume= 0.692 af
Outflow = 1.79 cfs @ 13.45 hrs, Volume= 0.692 af, Atten= 0%, Lag= 0.0 min
Primary = 1.79 cfs @ 13.45 hrs, Volume= 0.692 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 44.25' @ 13.45 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	43.50'	**15.0" Round Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 43.50' / 43.40' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 1.23 sf

Primary OutFlow Max=1.79 cfs @ 13.45 hrs HW=44.25' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 1.79 cfs @ 3.35 fps)



Summary for Pond SB 01 B: SB 01 B

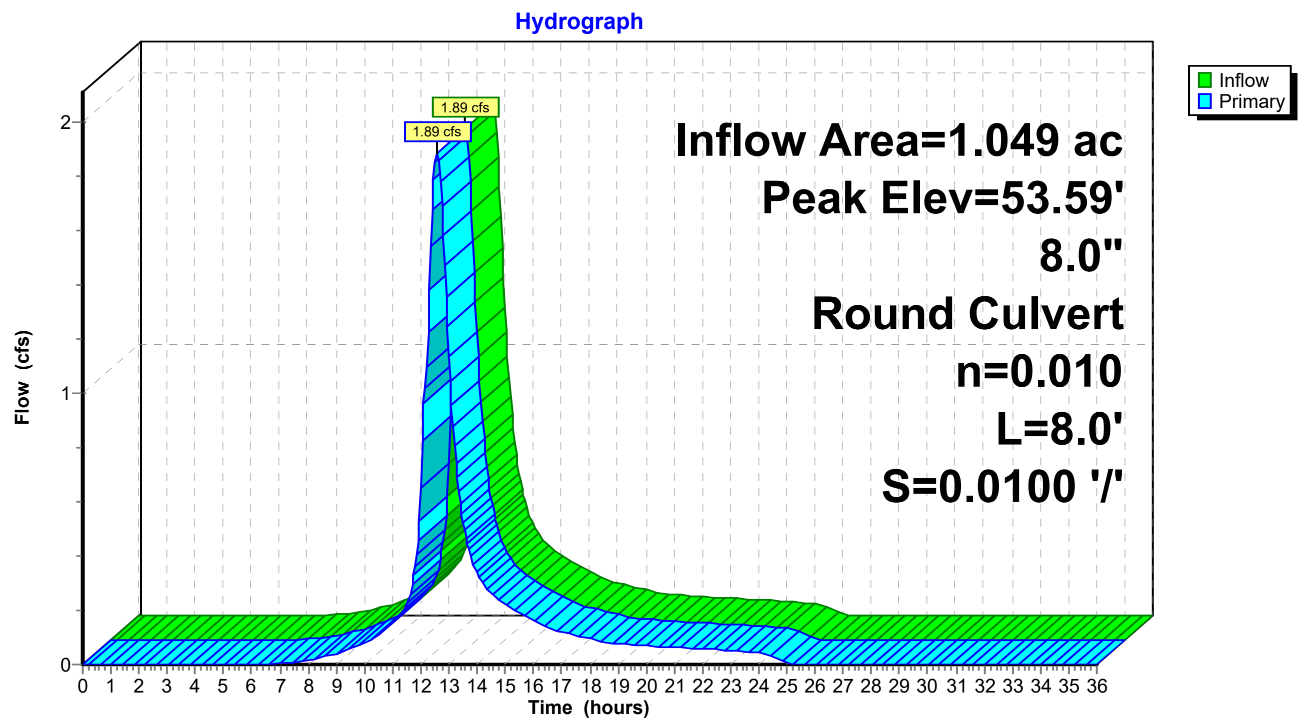
Inflow Area =	1.049 ac,	2.41% Impervious,	Inflow Depth = 3.45"	for 10 yr event	
Inflow =	1.89 cfs @	12.56 hrs,	Volume=	0.301 af	
Outflow =	1.89 cfs @	12.56 hrs,	Volume=	0.301 af,	Atten= 0%, Lag= 0.0 min
Primary =	1.89 cfs @	12.56 hrs,	Volume=	0.301 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 53.59' @ 12.56 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	52.00'	**8.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 52.00' / 51.92' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.35 sf

Primary OutFlow Max=1.88 cfs @ 12.56 hrs HW=53.59' TW=51.67' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 1.88 cfs @ 5.39 fps)

Pond SB 01 B: SB 01 B



Summary for Pond SB 01 S: SB 01 S

Inflow Area = 1.049 ac, 2.41% Impervious, Inflow Depth = 3.45" for 10 yr event
Inflow = 1.89 cfs @ 12.56 hrs, Volume= 0.301 af
Outflow = 1.41 cfs @ 12.88 hrs, Volume= 0.301 af, Atten= 25%, Lag= 18.8 min
Primary = 1.41 cfs @ 12.88 hrs, Volume= 0.301 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 51.77' @ 12.88 hrs Surf.Area= 0 sf Storage= 1,336 cf

Plug-Flow detention time= 6.5 min calculated for 0.301 af (100% of inflow)
Center-of-Mass det. time= 6.1 min (845.8 - 839.8)

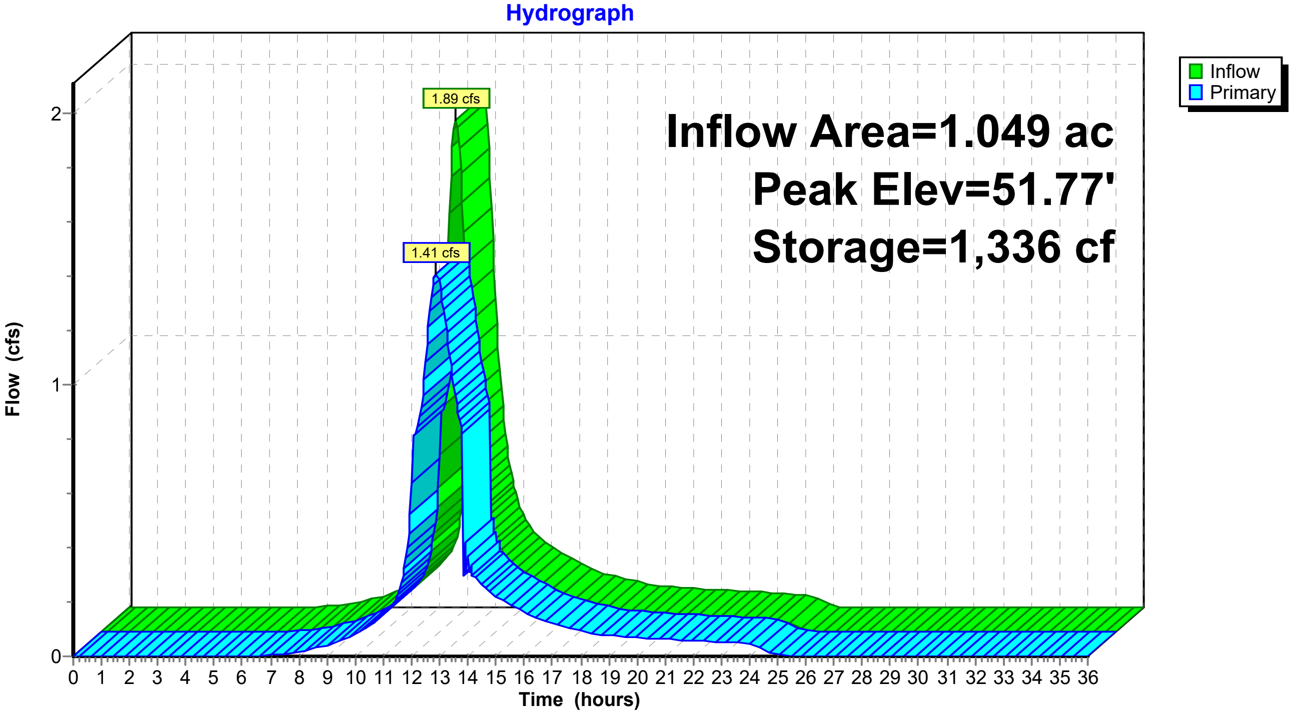
Volume	Invert	Avail.Storage	Storage Description
#1	50.64'	3,084 cf	**Custom Stage Data** Listed below

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
50.64	0	0
51.47	16	16
51.97	2,170	2,186
52.47	898	3,084

Device	Routing	Invert	Outlet Devices
#1	Primary	50.64'	**4.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	50.97'	**6.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	51.47'	**8.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=1.41 cfs @ 12.88 hrs HW=51.77' TW=50.68' (Dynamic Tailwater)
├─**1=Orifice/Grate** (Orifice Controls 0.41 cfs @ 4.73 fps)
├─**2=Orifice/Grate** (Orifice Controls 0.70 cfs @ 3.58 fps)
└─**3=Orifice/Grate** (Orifice Controls 0.29 cfs @ 1.88 fps)

Pond SB 01 S: SB 01 S



Summary for Pond SB 02 B: SB 02 B

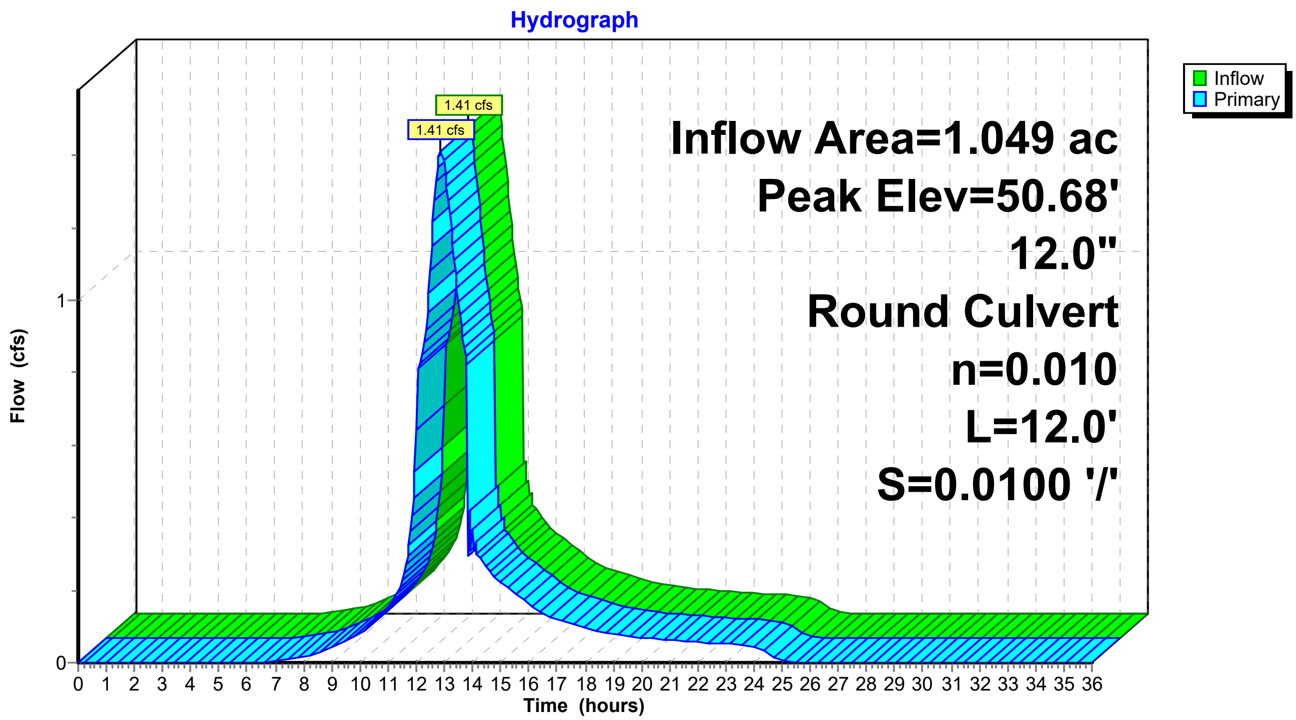
Inflow Area =	1.049 ac,	2.41% Impervious, Inflow Depth = 3.45"	for 10 yr event	
Inflow =	1.41 cfs @	12.88 hrs, Volume=	0.301 af	
Outflow =	1.41 cfs @	12.88 hrs, Volume=	0.301 af,	Atten= 0%, Lag= 0.0 min
Primary =	1.41 cfs @	12.88 hrs, Volume=	0.301 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 50.68' @ 12.88 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	49.97'	**12.0" Round Culvert** L= 12.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 49.97' / 49.85' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=1.41 cfs @ 12.88 hrs HW=50.68' TW=49.30' (Dynamic Tailwater)
↑**1=Culvert** (Barrel Controls 1.41 cfs @ 3.34 fps)

Pond SB 02 B: SB 02 B



Summary for Pond SB 11 B: SB 11 B

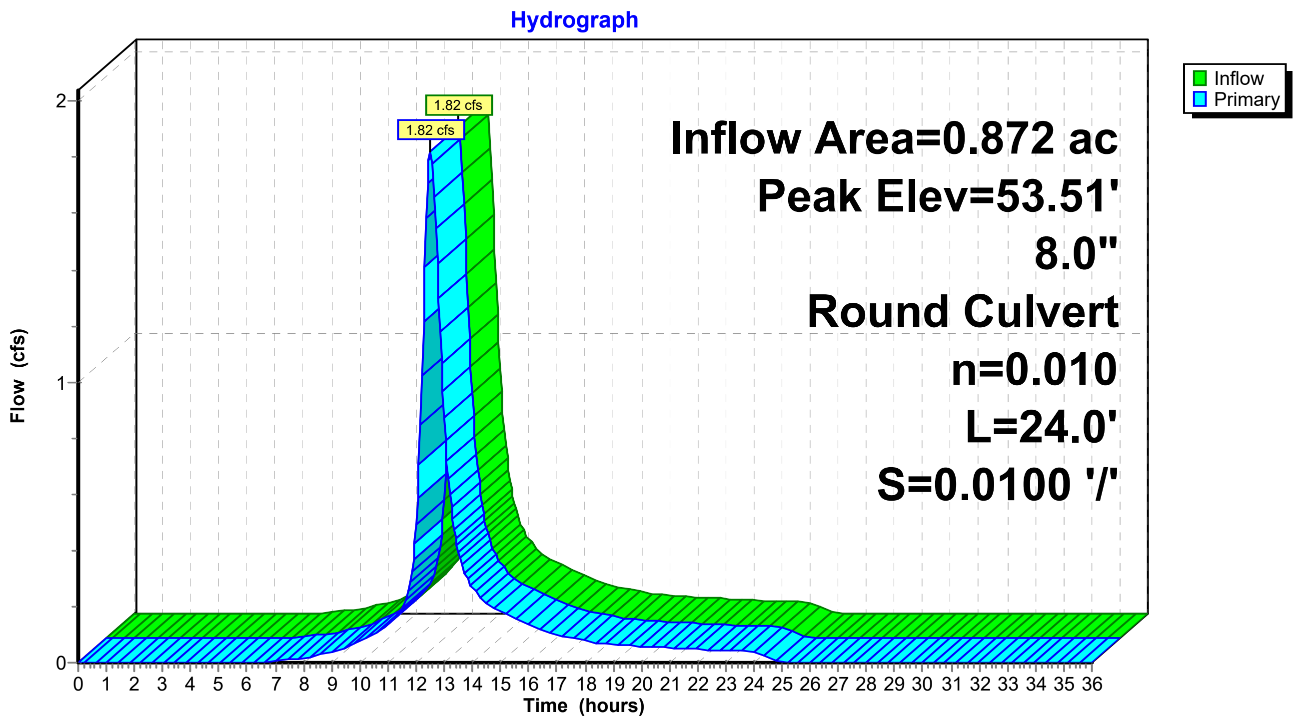
Inflow Area =	0.872 ac,	0.00% Impervious,	Inflow Depth = 3.53"	for 10 yr event	
Inflow =	1.82 cfs @	12.51 hrs,	Volume=	0.256 af	
Outflow =	1.82 cfs @	12.51 hrs,	Volume=	0.256 af,	Atten= 0%, Lag= 0.0 min
Primary =	1.82 cfs @	12.51 hrs,	Volume=	0.256 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 53.51' @ 12.51 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	52.00'	**8.0" Round Culvert** L= 24.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 52.00' / 51.76' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.35 sf

Primary OutFlow Max=1.82 cfs @ 12.51 hrs HW=53.50' TW=51.84' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 1.82 cfs @ 5.21 fps)

Pond SB 11 B: SB 11 B



Summary for Pond SB 11 S: SB 11 S

Inflow Area = 0.872 ac, 0.00% Impervious, Inflow Depth = 3.53" for 10 yr event
Inflow = 1.82 cfs @ 12.51 hrs, Volume= 0.256 af
Outflow = 1.29 cfs @ 12.81 hrs, Volume= 0.256 af, Atten= 29%, Lag= 17.9 min
Primary = 1.29 cfs @ 12.81 hrs, Volume= 0.256 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 51.95' @ 12.81 hrs Surf.Area= 0 sf Storage= 1,136 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 5.3 min (840.7 - 835.4)

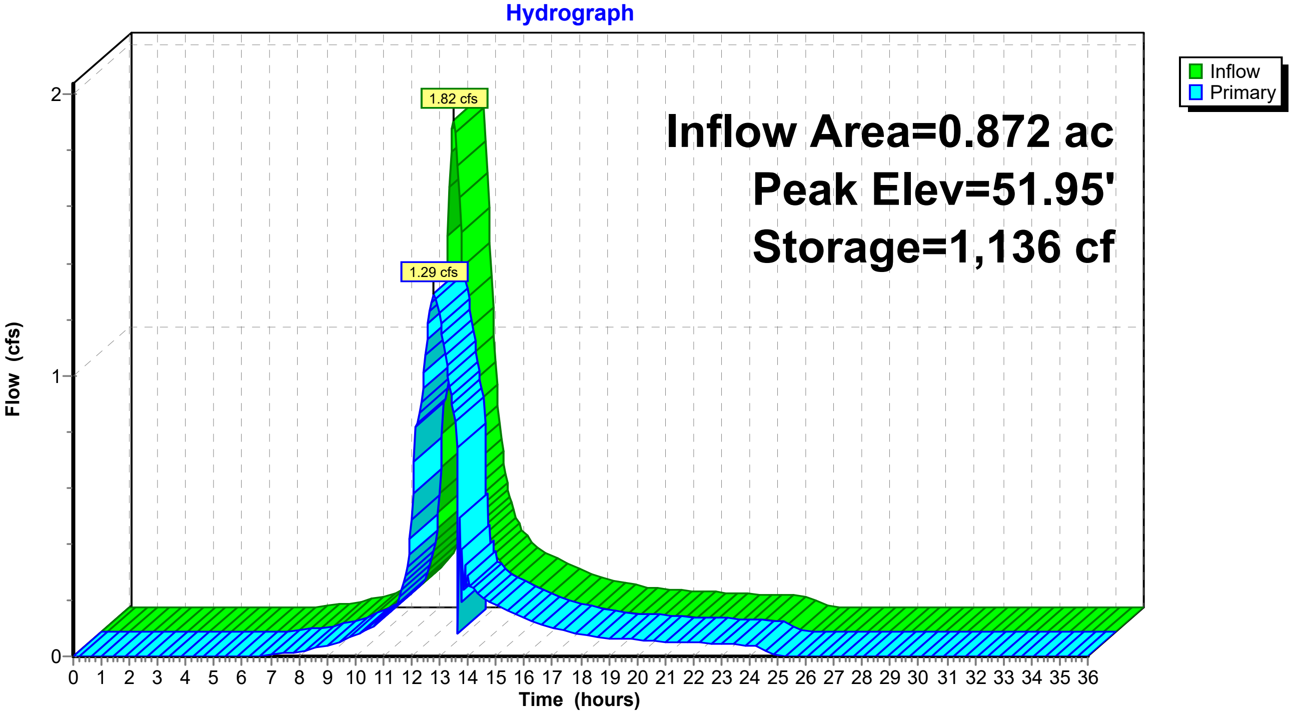
Volume	Invert	Avail.Storage	Storage Description
#1	50.84'	2,892 cf	**Custom Stage Data** Listed below

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
50.84	0	0
51.67	16	16
52.17	2,035	2,051
52.67	841	2,892

Device	Routing	Invert	Outlet Devices
#1	Primary	50.84'	**4.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	51.17'	**6.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	51.67'	**6.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=1.29 cfs @ 12.81 hrs HW=51.94' TW=50.77' (Dynamic Tailwater)
—**1=Orifice/Grate** (Orifice Controls 0.41 cfs @ 4.66 fps)
—**2=Orifice/Grate** (Orifice Controls 0.68 cfs @ 3.49 fps)
—**3=Orifice/Grate** (Orifice Controls 0.20 cfs @ 1.78 fps)

Pond SB 11 S: SB 11 S



Summary for Pond SB 12 B: SB 12 B

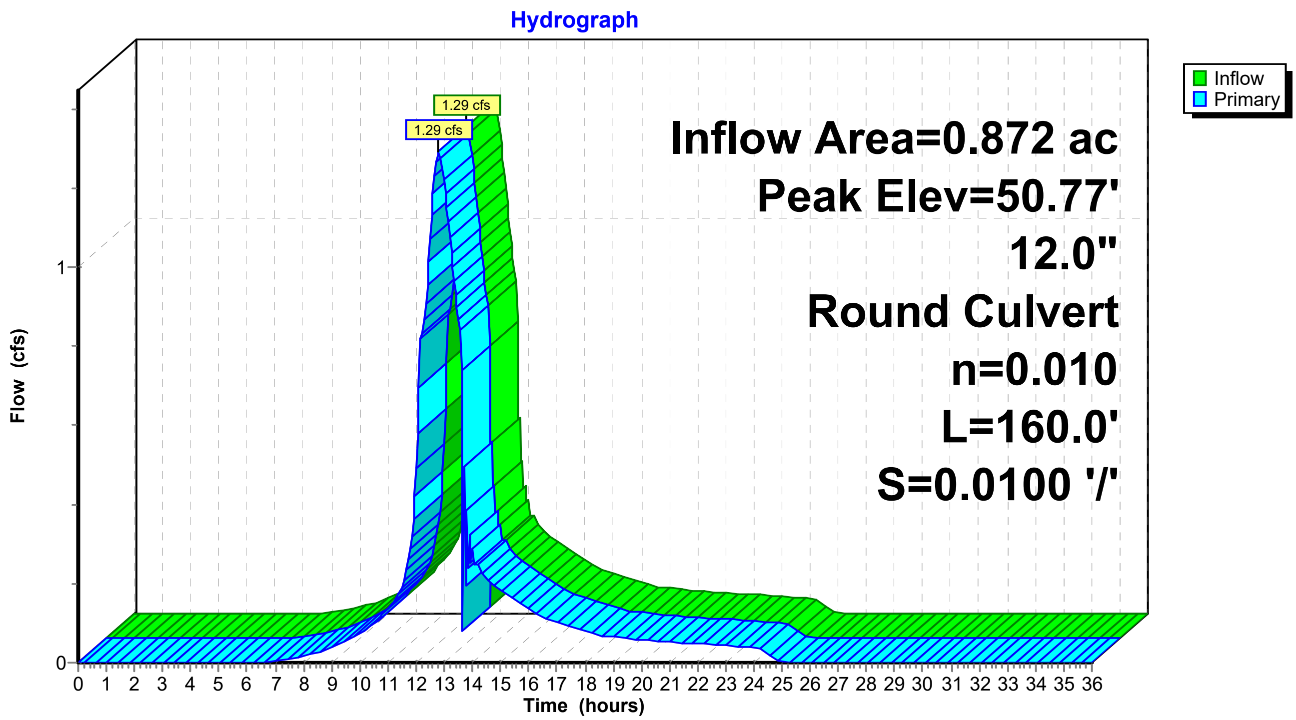
Inflow Area =	0.872 ac,	0.00% Impervious,	Inflow Depth = 3.53"	for 10 yr event	
Inflow =	1.29 cfs @	12.81 hrs,	Volume=	0.256 af	
Outflow =	1.29 cfs @	12.81 hrs,	Volume=	0.256 af,	Atten= 0%, Lag= 0.0 min
Primary =	1.29 cfs @	12.81 hrs,	Volume=	0.256 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 50.77' @ 12.81 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	50.17'	**12.0" Round Culvert** L= 160.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 50.17' / 48.57' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=1.29 cfs @ 12.81 hrs HW=50.77' TW=49.30' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 1.29 cfs @ 2.63 fps)

Pond SB 12 B: SB 12 B

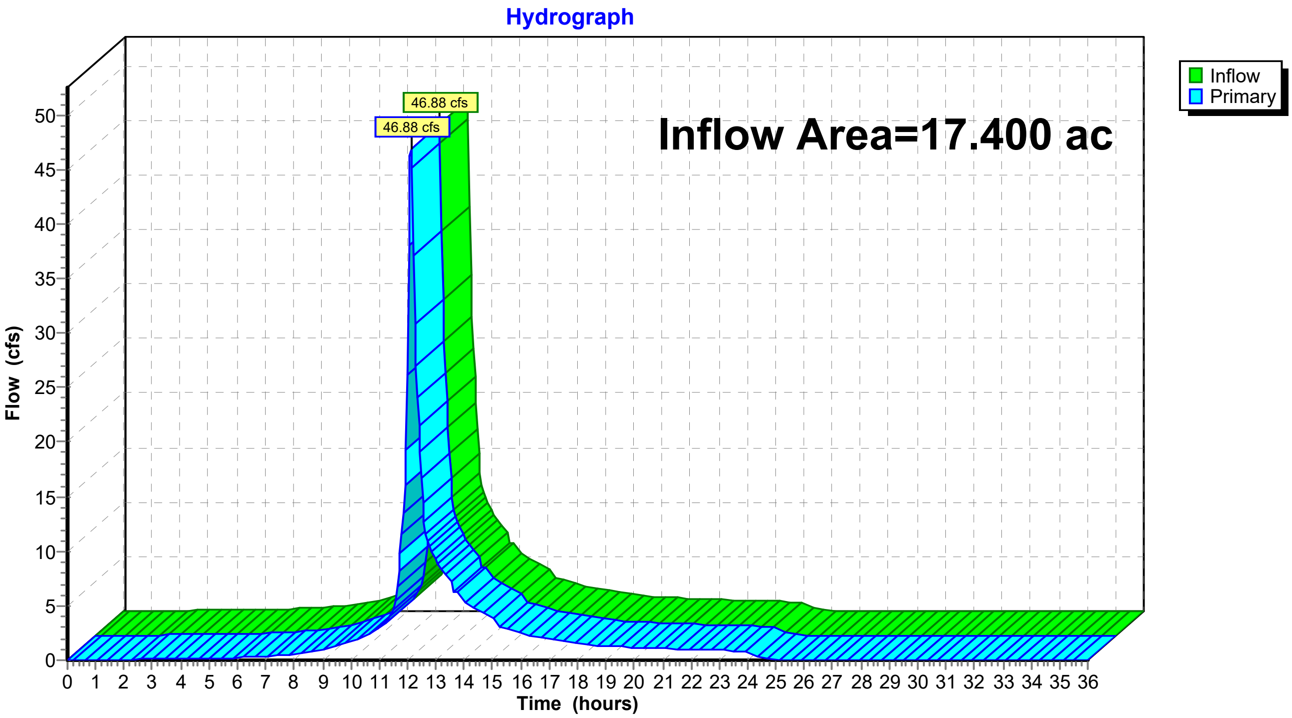


Summary for Link POA: POA

Inflow Area =	17.400 ac,	49.60% Impervious,	Inflow Depth > 3.43"	for 10 yr event
Inflow =	46.88 cfs @	12.12 hrs, Volume=	4.978 af	
Primary =	46.88 cfs @	12.12 hrs, Volume=	4.978 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Link POA: POA



Summary for Subcatchment PR-1: PR-1

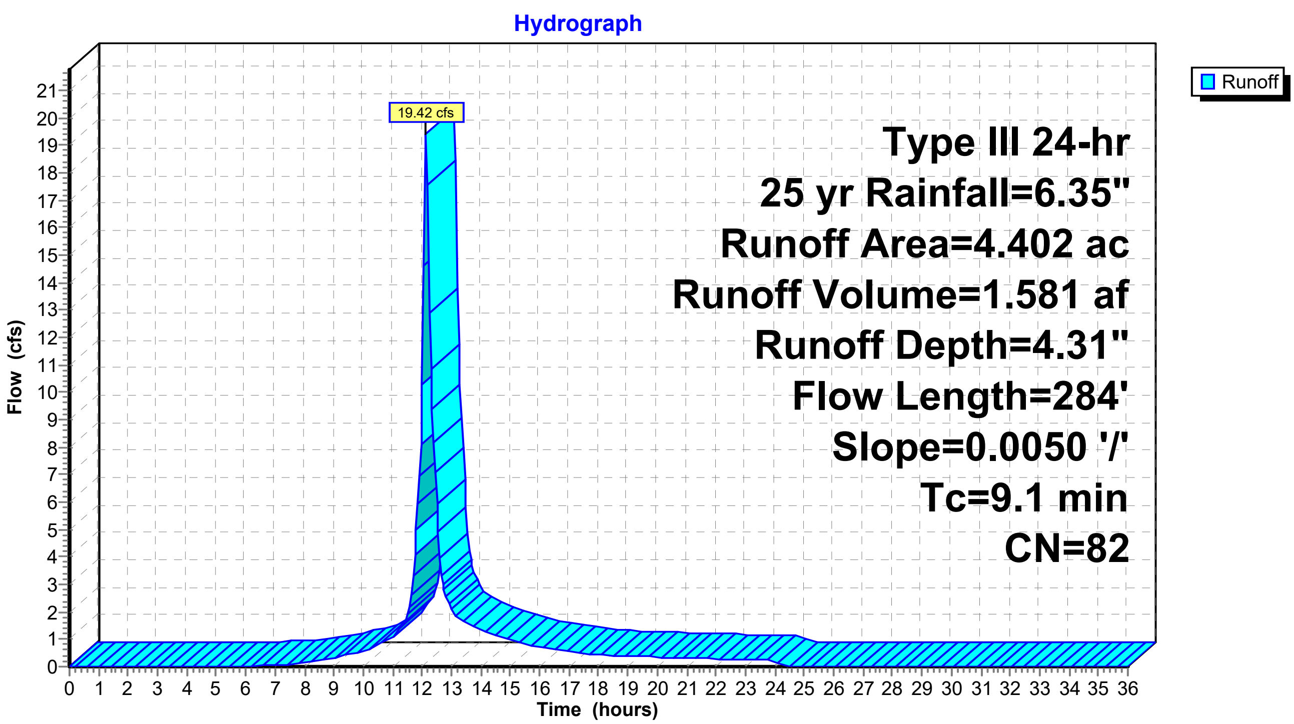
Runoff = 19.42 cfs @ 12.13 hrs, Volume= 1.581 af, Depth= 4.31"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=6.35"

Area (ac)	CN	Description
1.892	61	>75% Grass cover, Good, HSG B
2.510	98	Paved parking, HSG B
4.402	82	Weighted Average
1.892		42.98% Pervious Area
2.510		57.02% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	50	0.0050	0.69		**Sheet Flow, A-B** Smooth surfaces n= 0.011 P2= 3.20"
7.9	234	0.0050	0.49		**Shallow Concentrated Flow, B-C** Short Grass Pasture Kv= 7.0 fps
9.1	284	Total			

Subcatchment PR-1: PR-1



Summary for Subcatchment PR-1A: PR-1A

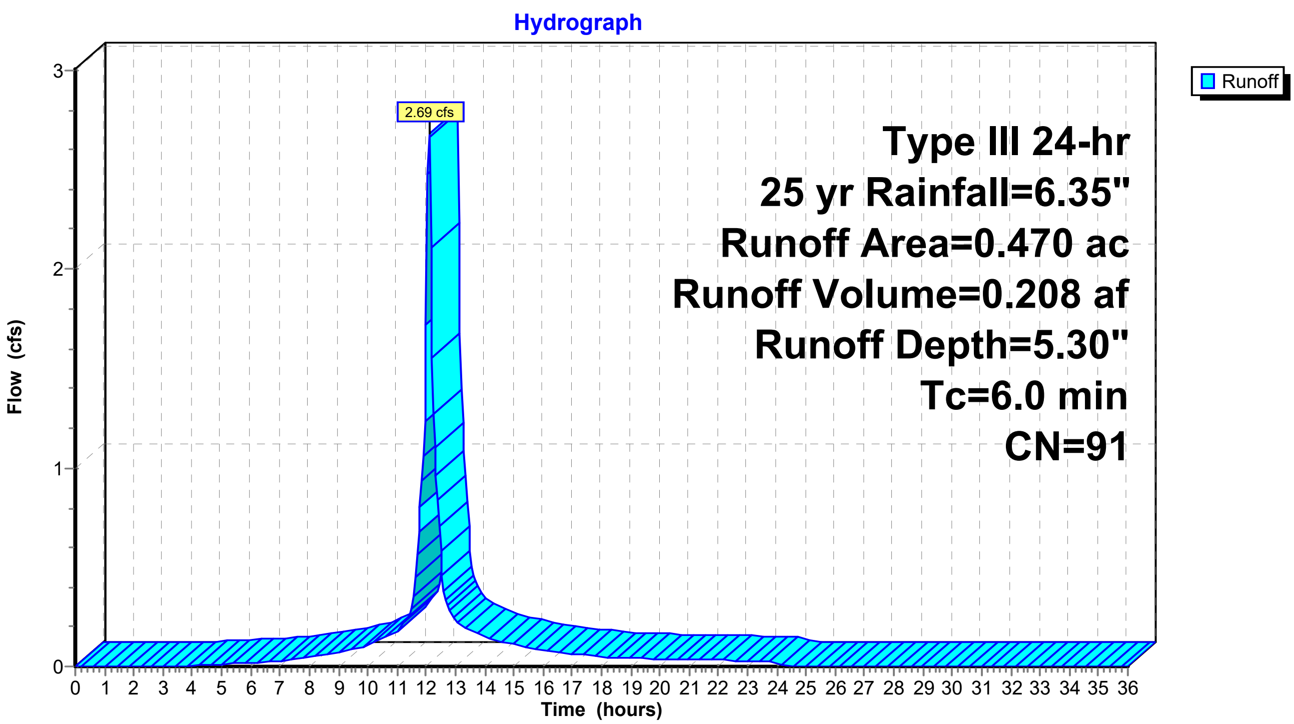
Runoff = 2.69 cfs @ 12.09 hrs, Volume= 0.208 af, Depth= 5.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=6.35"

Area (ac)	CN	Description
0.090	61	>75% Grass cover, Good, HSG B
0.380	98	Paved parking, HSG B
0.470	91	Weighted Average
0.090		19.15% Pervious Area
0.380		80.85% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-1A: PR-1A



Summary for Subcatchment PR-1B: PR-1B

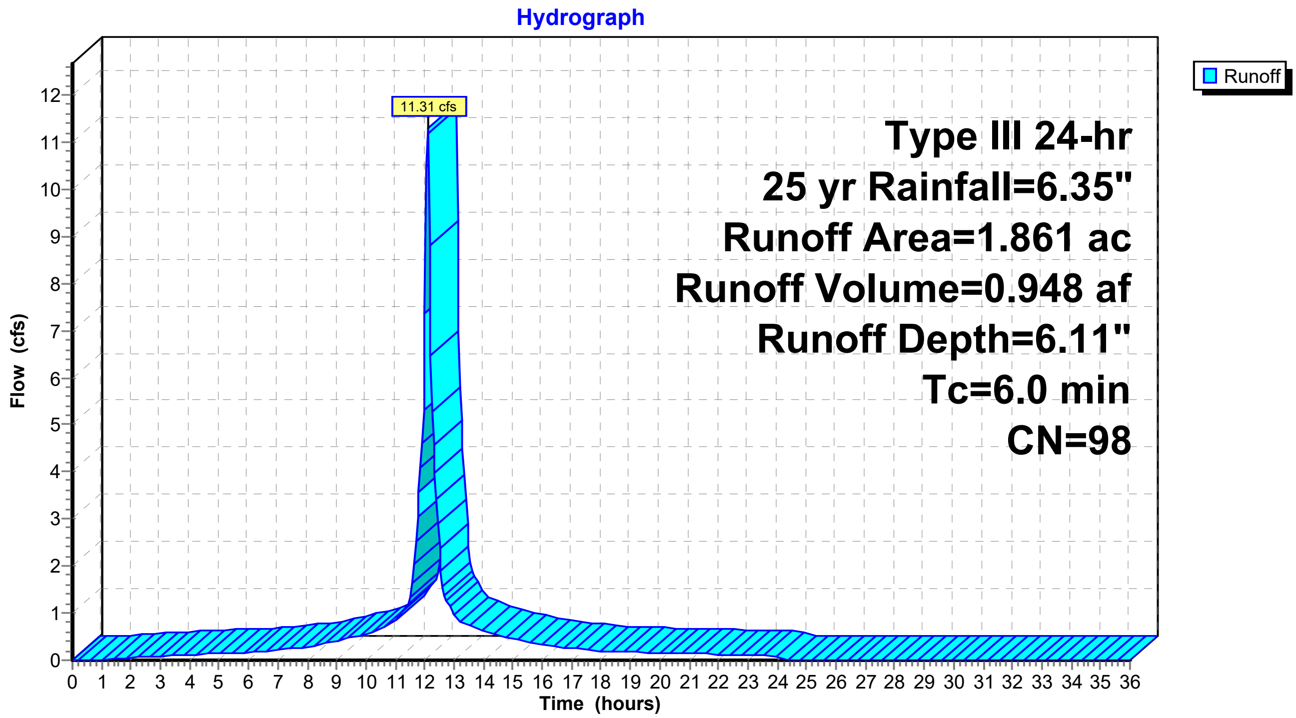
Runoff = 11.31 cfs @ 12.09 hrs, Volume= 0.948 af, Depth= 6.11"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=6.35"

Area (ac)	CN	Description
1.861	98	Roofs, HSG B
1.861		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-1B: PR-1B



Summary for Subcatchment PR-1C: PR-1C

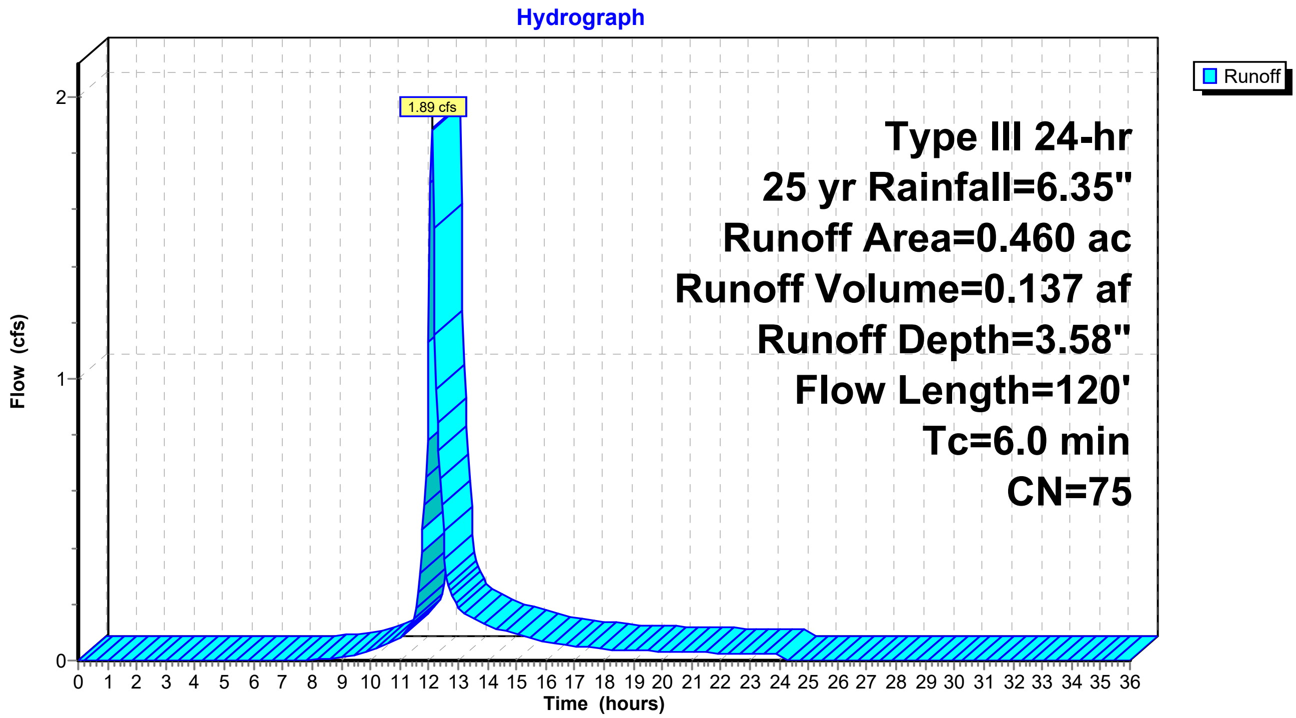
Runoff = 1.89 cfs @ 12.09 hrs, Volume= 0.137 af, Depth= 3.58"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=6.35"

Area (ac)	CN	Description
0.020	55	Woods, Good, HSG B
0.260	61	>75% Grass cover, Good, HSG B
0.180	98	Paved parking, HSG B
0.460	75	Weighted Average
0.280		60.87% Pervious Area
0.180		39.13% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	20	0.0700	0.09		**Sheet Flow, 20' SF** Woods: Light underbrush n= 0.400 P2= 3.20"
1.9	40	0.5000	0.35		**Sheet Flow, 30' SF** Grass: Dense n= 0.240 P2= 3.20"
0.1	12	0.0100	1.61		**Shallow Concentrated Flow, 12' SCF** Unpaved Kv= 16.1 fps
0.2	48	0.0400	4.06		**Shallow Concentrated Flow, 48' SCF** Paved Kv= 20.3 fps
5.8	120	Total, Increased to minimum Tc = 6.0 min			

Subcatchment PR-1C: PR-1C



Summary for Subcatchment PR-1D: PR-1D

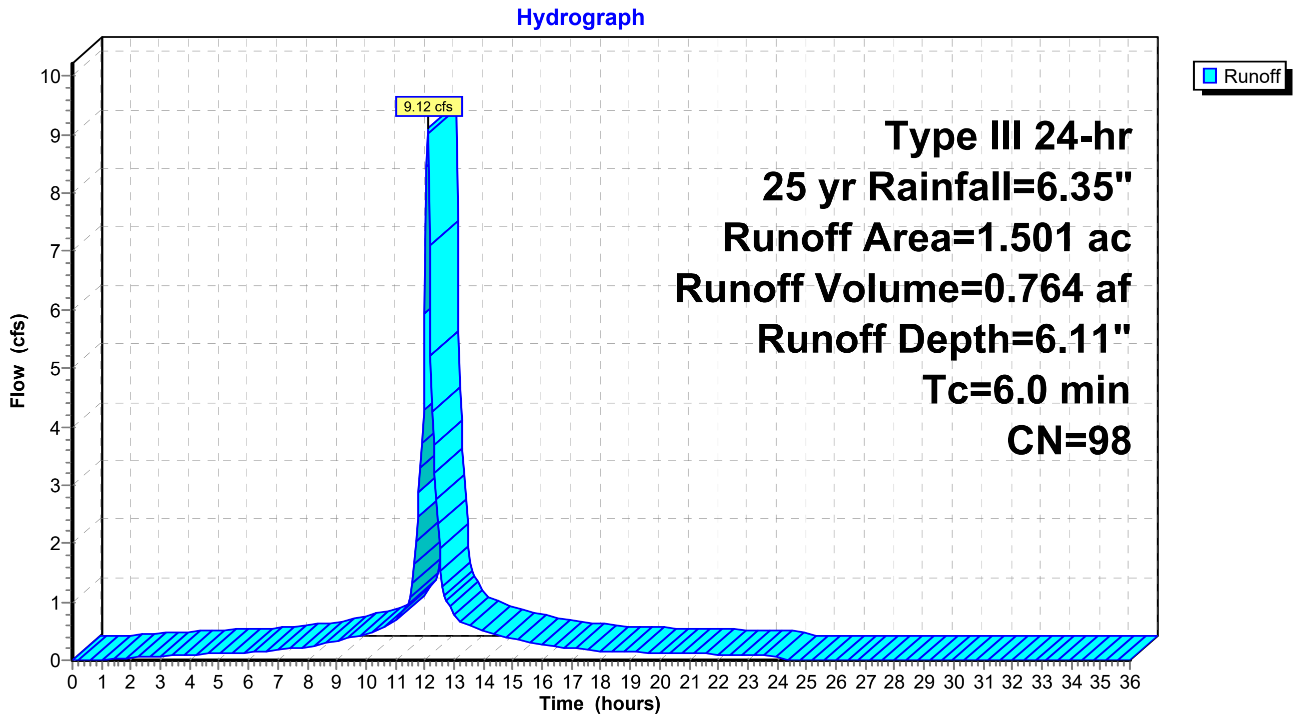
Runoff = 9.12 cfs @ 12.09 hrs, Volume= 0.764 af, Depth= 6.11"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=6.35"

Area (ac)	CN	Description
1.501	98	Roofs, HSG B
1.501		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-1D: PR-1D



Summary for Subcatchment PR-1E: PR-1E

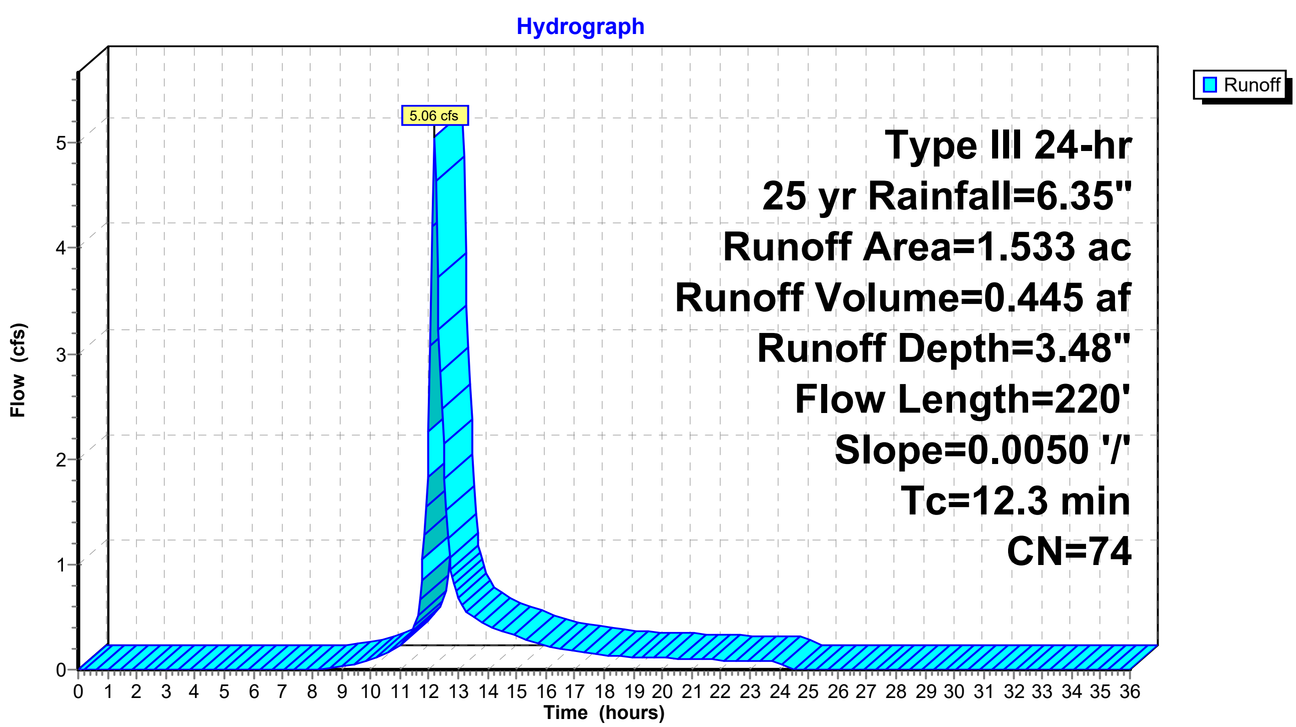
Runoff = 5.06 cfs @ 12.17 hrs, Volume= 0.445 af, Depth= 3.48"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=6.35"

Area (ac)	CN	Description
1.000	61	>75% Grass cover, Good, HSG B
0.533	98	Paved parking, HSG B
1.533	74	Weighted Average
1.000		65.23% Pervious Area
0.533		34.77% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.8	50	0.0050	0.09		**Sheet Flow, 50' SF** Grass: Short n= 0.150 P2= 3.20"
2.5	170	0.0050	1.14		**Shallow Concentrated Flow, 170' SCF** Unpaved Kv= 16.1 fps
12.3	220	Total			

Subcatchment PR-1E: PR-1E



Summary for Subcatchment PR-2: PR-2

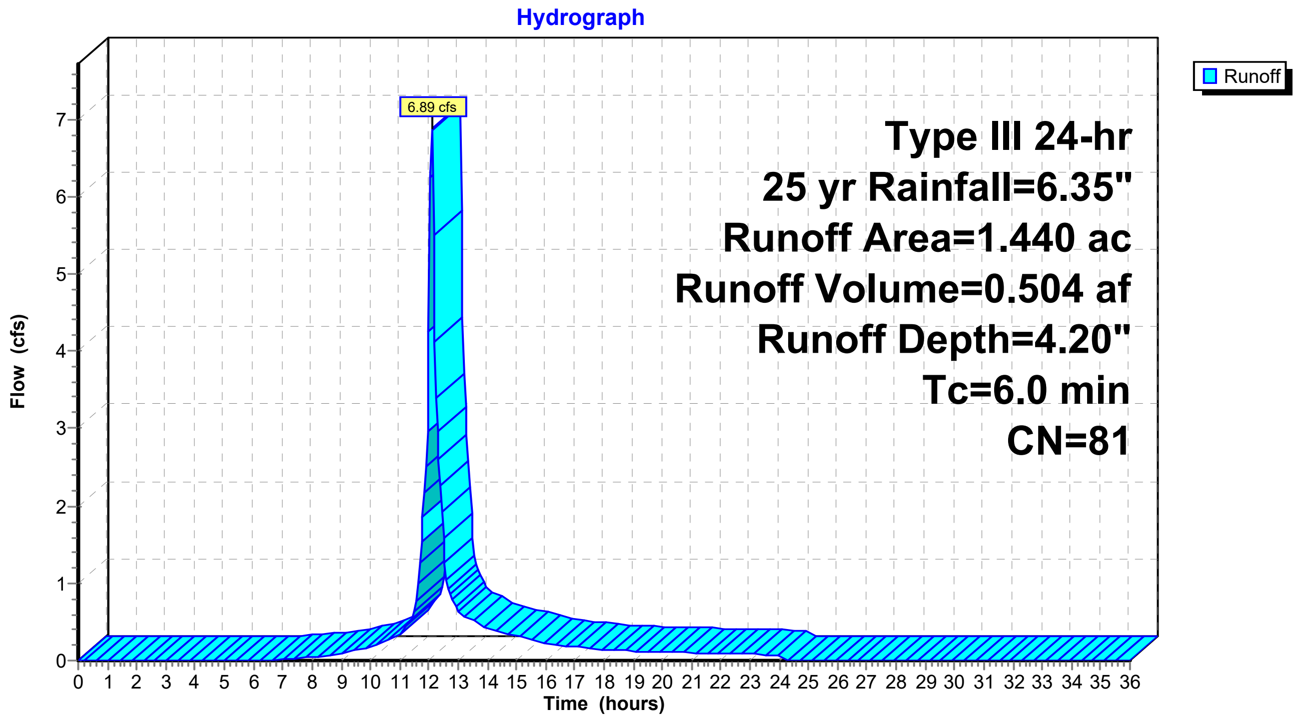
Runoff = 6.89 cfs @ 12.09 hrs, Volume= 0.504 af, Depth= 4.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=6.35"

Area (ac)	CN	Description
0.672	61	>75% Grass cover, Good, HSG B
0.768	98	Paved parking, HSG B
1.440	81	Weighted Average
0.672		46.67% Pervious Area
0.768		53.33% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-2: PR-2



Summary for Subcatchment PR-2B: PR-2B

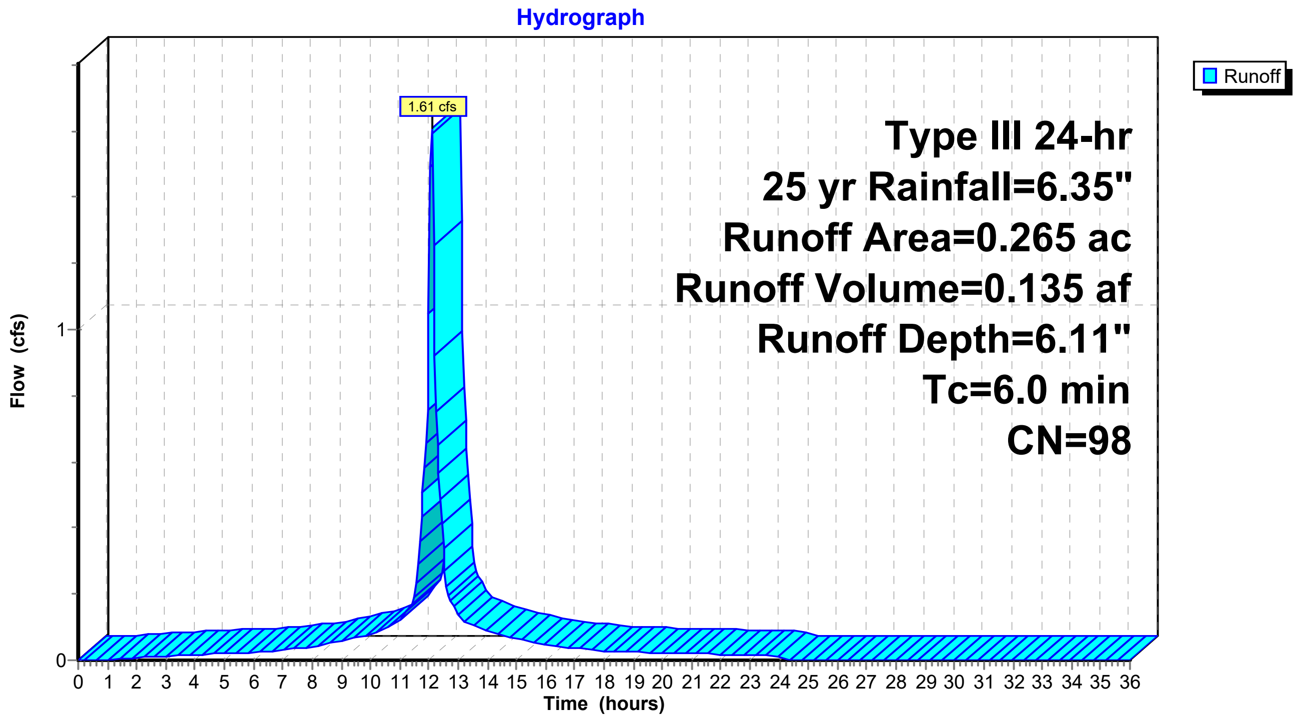
Runoff = 1.61 cfs @ 12.09 hrs, Volume= 0.135 af, Depth= 6.11"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=6.35"

Area (ac)	CN	Description
0.265	98	Roofs, HSG B
0.265		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-2B: PR-2B



Summary for Subcatchment PR-3A: PR-3A

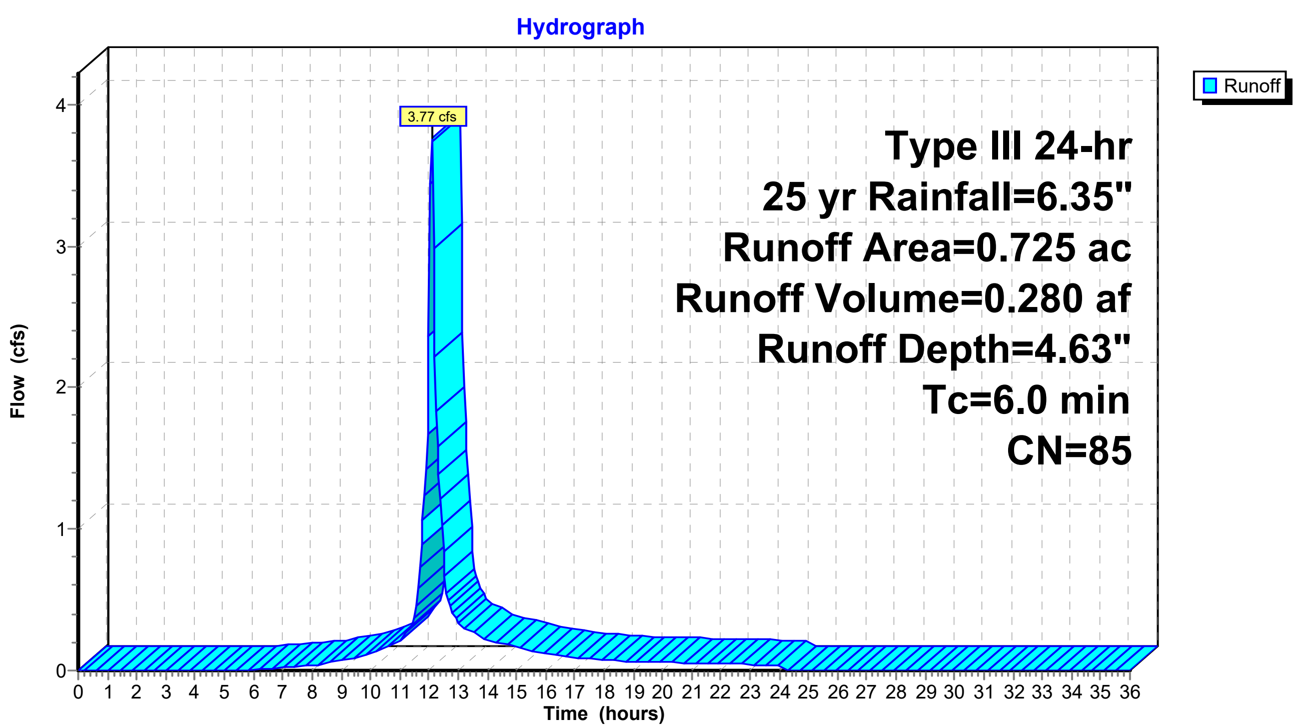
Runoff = 3.77 cfs @ 12.09 hrs, Volume= 0.280 af, Depth= 4.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=6.35"

Area (ac)	CN	Description
0.249	61	>75% Grass cover, Good, HSG B
0.476	98	Paved parking, HSG B
0.725	85	Weighted Average
0.249		34.34% Pervious Area
0.476		65.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-3A: PR-3A



Summary for Subcatchment PR-3B: PR-3B

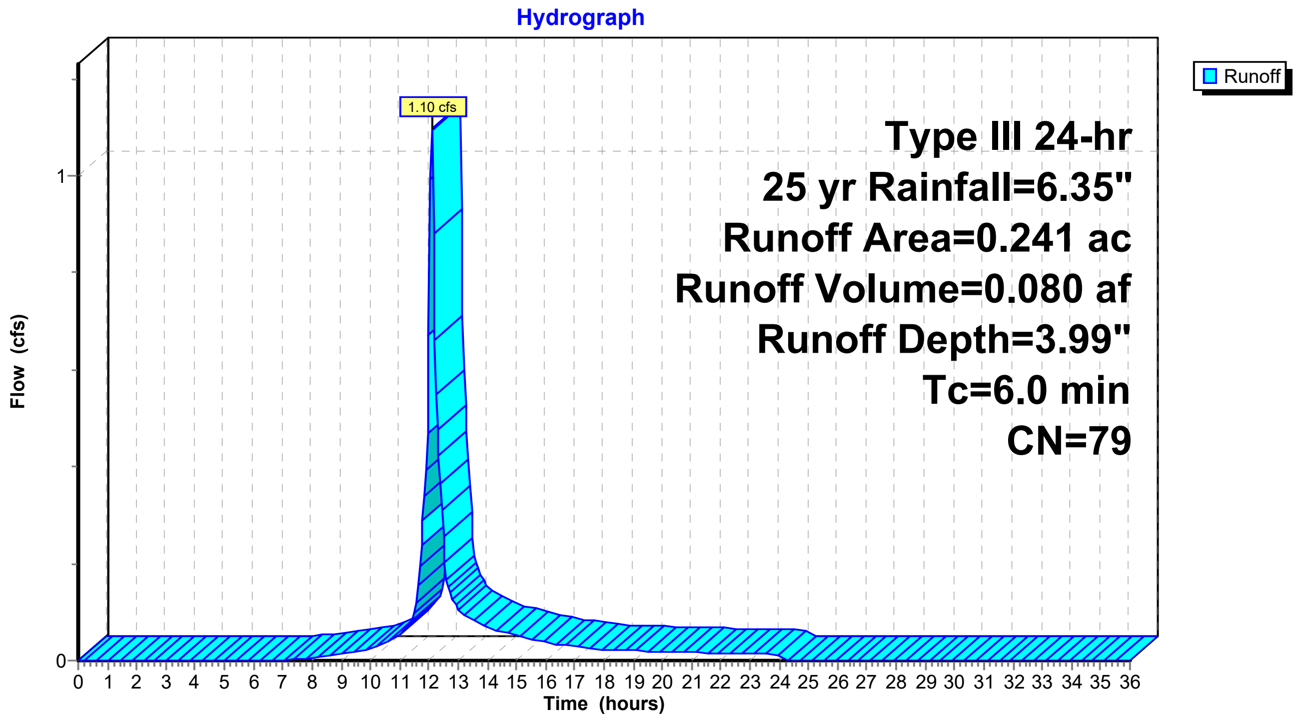
Runoff = 1.10 cfs @ 12.09 hrs, Volume= 0.080 af, Depth= 3.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=6.35"

Area (ac)	CN	Description
0.124	61	>75% Grass cover, Good, HSG B
0.117	98	Paved parking, HSG B
0.241	79	Weighted Average
0.124		51.45% Pervious Area
0.117		48.55% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-3B: PR-3B



Summary for Subcatchment PR-3C: PR-3C

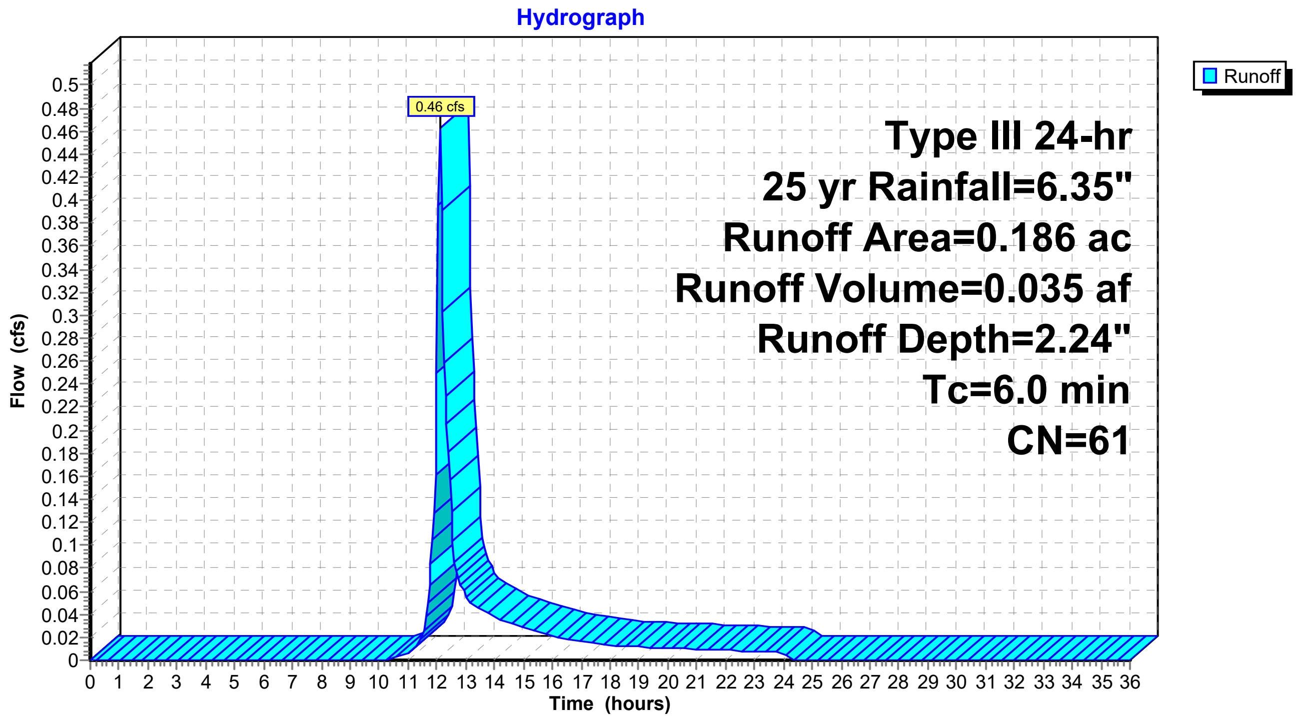
Runoff = 0.46 cfs @ 12.10 hrs, Volume= 0.035 af, Depth= 2.24"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=6.35"

Area (ac)	CN	Description
0.186	61	>75% Grass cover, Good, HSG B
0.186		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-3C: PR-3C



Summary for Subcatchment PR-4A: SB 01 A

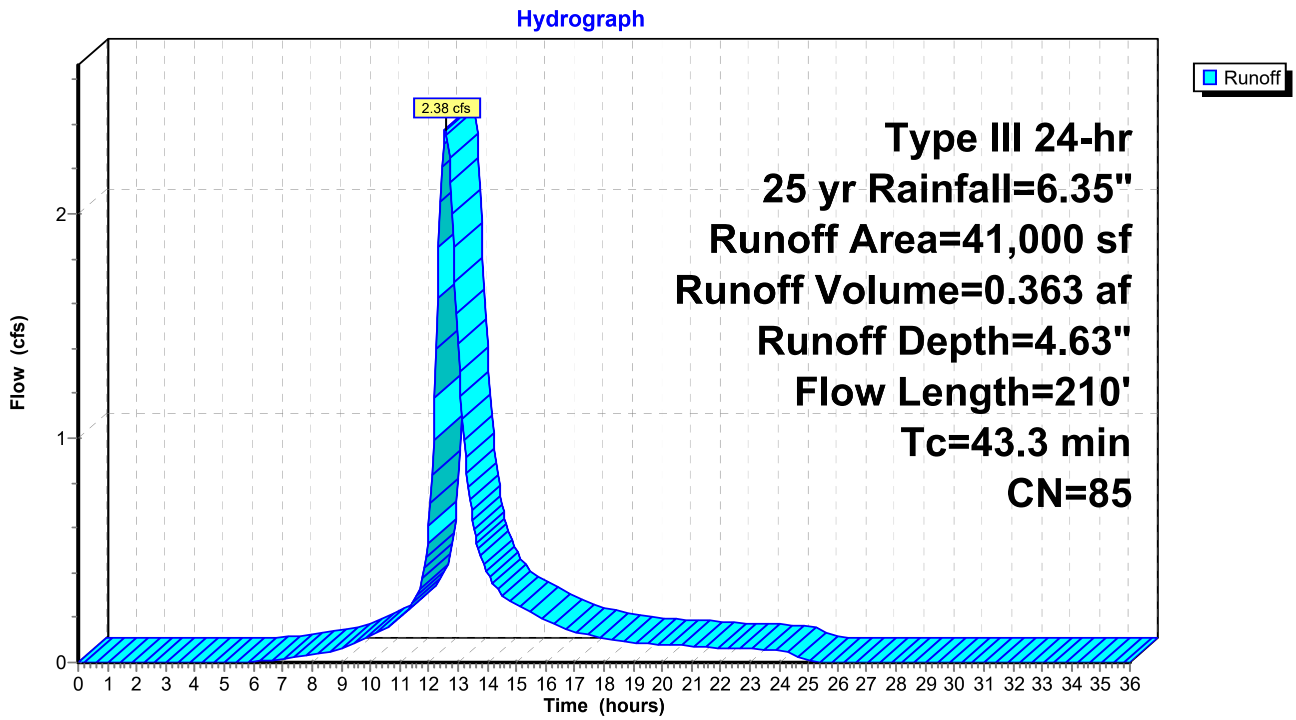
Runoff = 2.38 cfs @ 12.57 hrs, Volume= 0.363 af, Depth= 4.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=6.35"

	Area (sf)	CN	Description
*	41,000	85	SYNTHETIC TURF- PAD- LINER
	41,000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
39.6	110	0.0055	0.05		**Sheet Flow, Through Turf Section** Grass: Bermuda n= 0.410 P2= 3.20"
3.7	100	0.0001	0.45	0.16	**Pipe Channel, TRENCH DRAIN LEVEL** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010
43.3	210	Total			

Subcatchment PR-4A: SB 01 A



Summary for Subcatchment PR-4B: SB 11 A

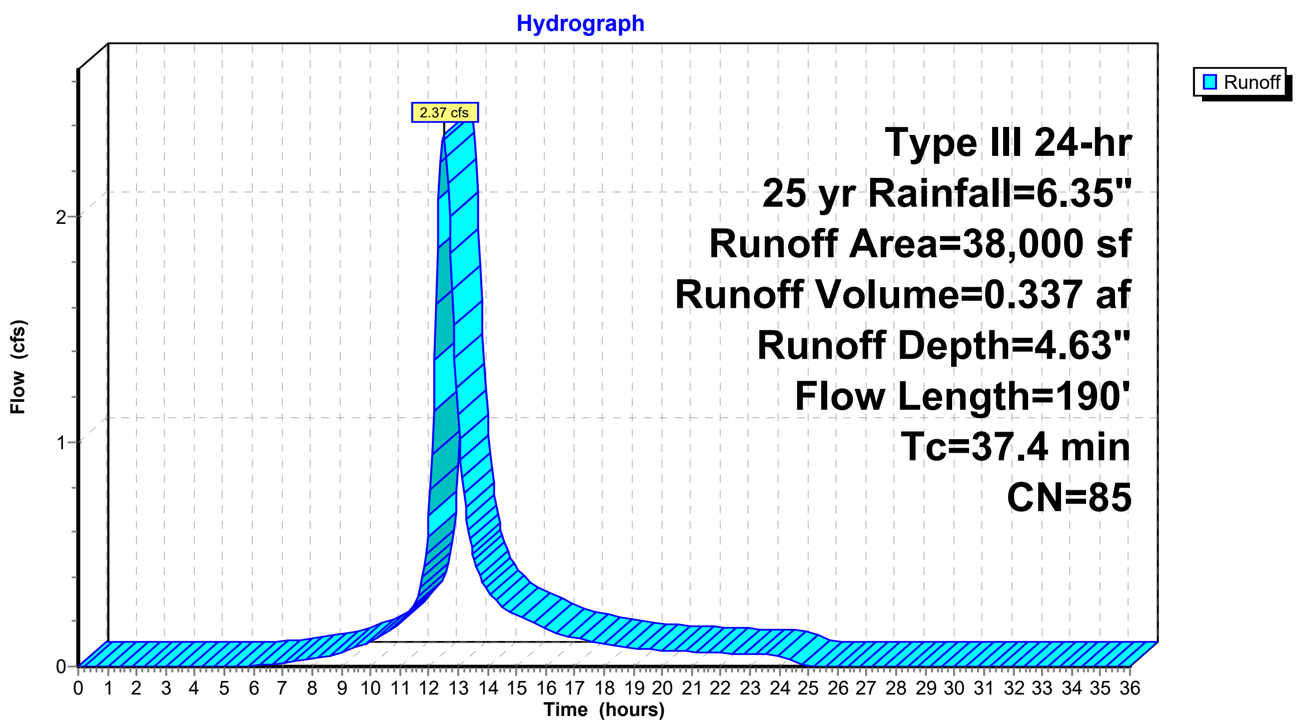
Runoff = 2.37 cfs @ 12.50 hrs, Volume= 0.337 af, Depth= 4.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=6.35"

	Area (sf)	CN	Description
*	38,000	85	SYNTHETIC TURF- PAD- LINER
	38,000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
33.7	90	0.0055	0.04		**Sheet Flow, Through Turf Section** Grass: Bermuda n= 0.410 P2= 3.20"
3.7	100	0.0001	0.45	0.16	**Pipe Channel, TRENCH DRAIN LEVEL** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010
37.4	190	Total			

Subcatchment PR-4B: SB 11 A



Summary for Subcatchment PR-4C: SB 00 DPW SLOPE

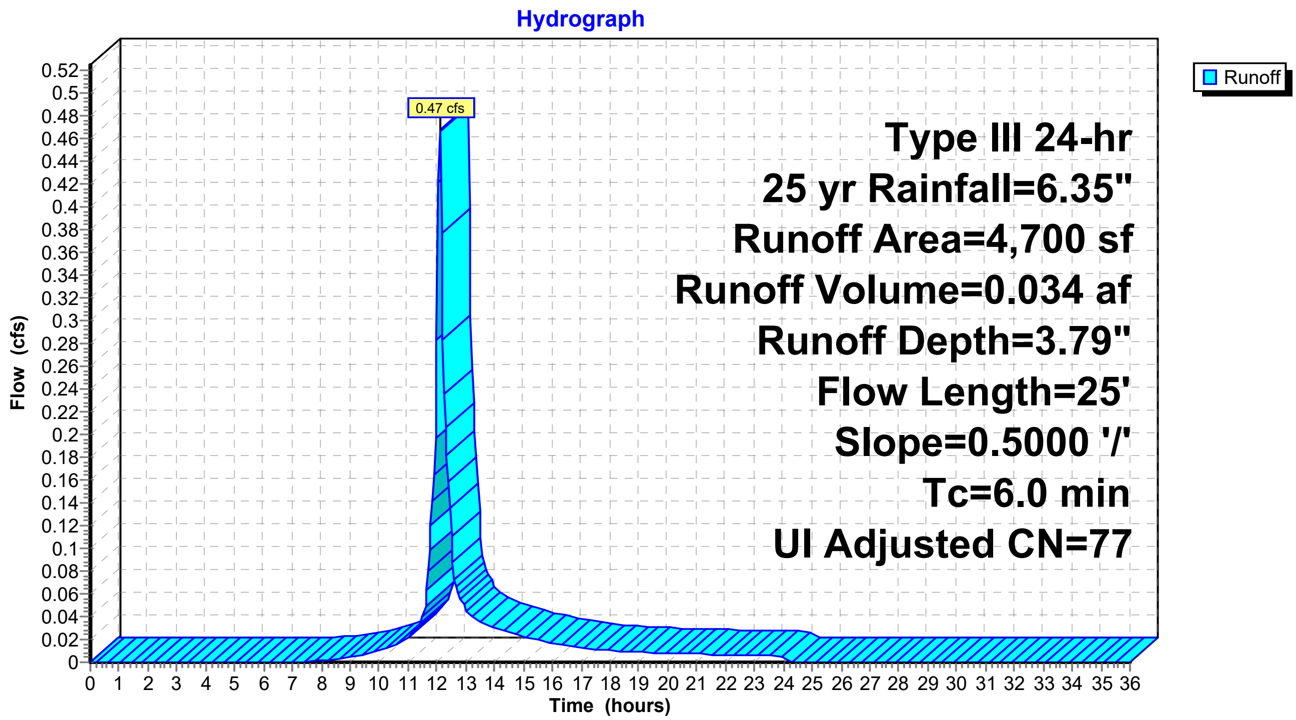
Runoff = 0.47 cfs @ 12.09 hrs, Volume= 0.034 af, Depth= 3.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=6.35"

Area (sf)	CN	Adj	Description
1,100	98		Unconnected pavement, HSG A
3,600	74		>75% Grass cover, Good, HSG C
4,700	80	77	Weighted Average, UI Adjusted
3,600			76.60% Pervious Area
1,100			23.40% Impervious Area
1,100			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.3	25	0.5000	0.32		**Sheet Flow, SLOPING LAND** Grass: Dense n= 0.240 P2= 3.20"
1.3	25	Total, Increased to minimum Tc = 6.0 min			

Subcatchment PR-4C: SB 00 DPW SLOPE



Summary for Subcatchment PR-5A: BB 01 A

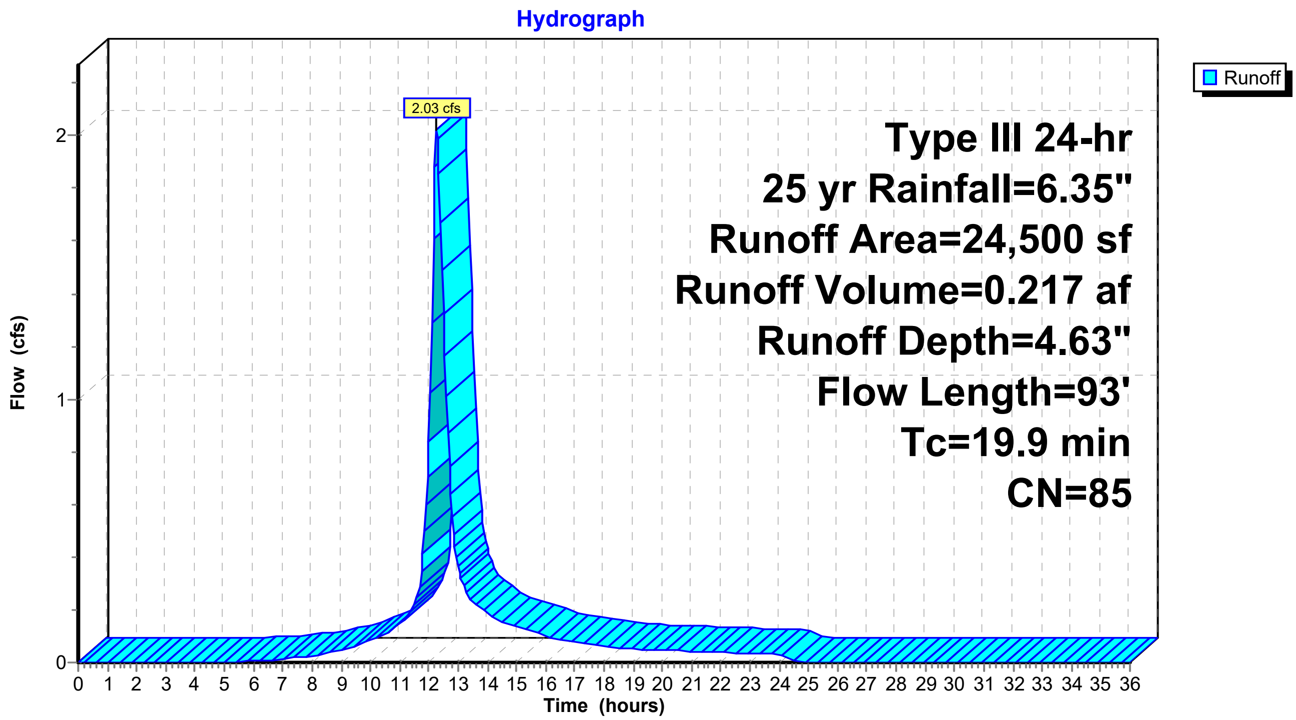
Runoff = 2.03 cfs @ 12.27 hrs, Volume= 0.217 af, Depth= 4.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=6.35"

	Area (sf)	CN	Description
*	24,500	85	SYNTHETIC TURF- PAD- LINER
	24,500		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.2	46	0.0067	0.04		**Sheet Flow, Through Turf Section** Grass: Bermuda n= 0.410 P2= 3.20"
1.7	47	0.0001	0.45	0.16	**Pipe Channel, TRENCH DRAIN LEVEL** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010
19.9	93	Total			

Subcatchment PR-5A: BB 01 A



Summary for Subcatchment PR-5B: BB 11 A

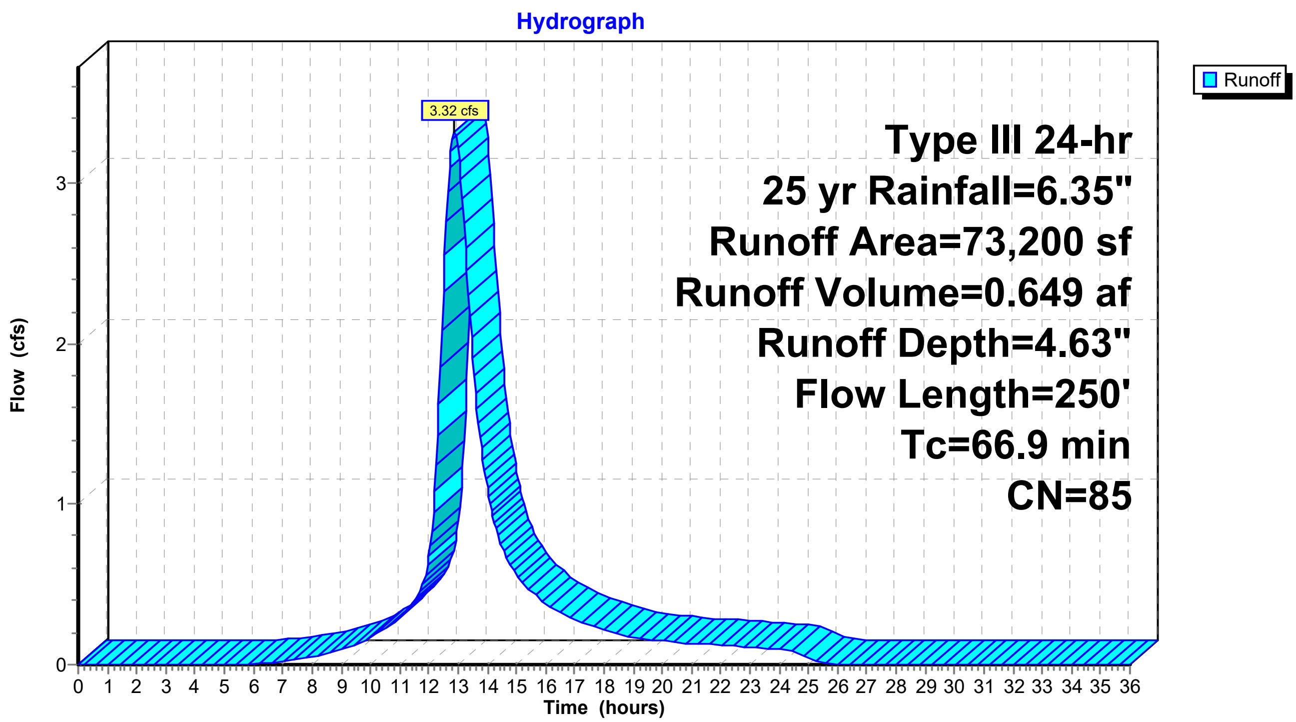
Runoff = 3.32 cfs @ 12.87 hrs, Volume= 0.649 af, Depth= 4.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=6.35"

	Area (sf)	CN	Description
*	73,200	85	SYNTHETIC TURF- PAD- LINER
	73,200		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.1	53	0.0055	0.04		**Sheet Flow, Through Turf Section** Grass: Bermuda n= 0.410 P2= 3.20"
43.1	150	0.0083	0.06		**Sheet Flow, SYNTHETIC TURF** Grass: Bermuda n= 0.410 P2= 3.20"
1.7	47	0.0001	0.45	0.16	**Pipe Channel, TRENCH DRAIN LEVEL** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010
66.9	250	Total			

Subcatchment PR-5B: BB 11 A



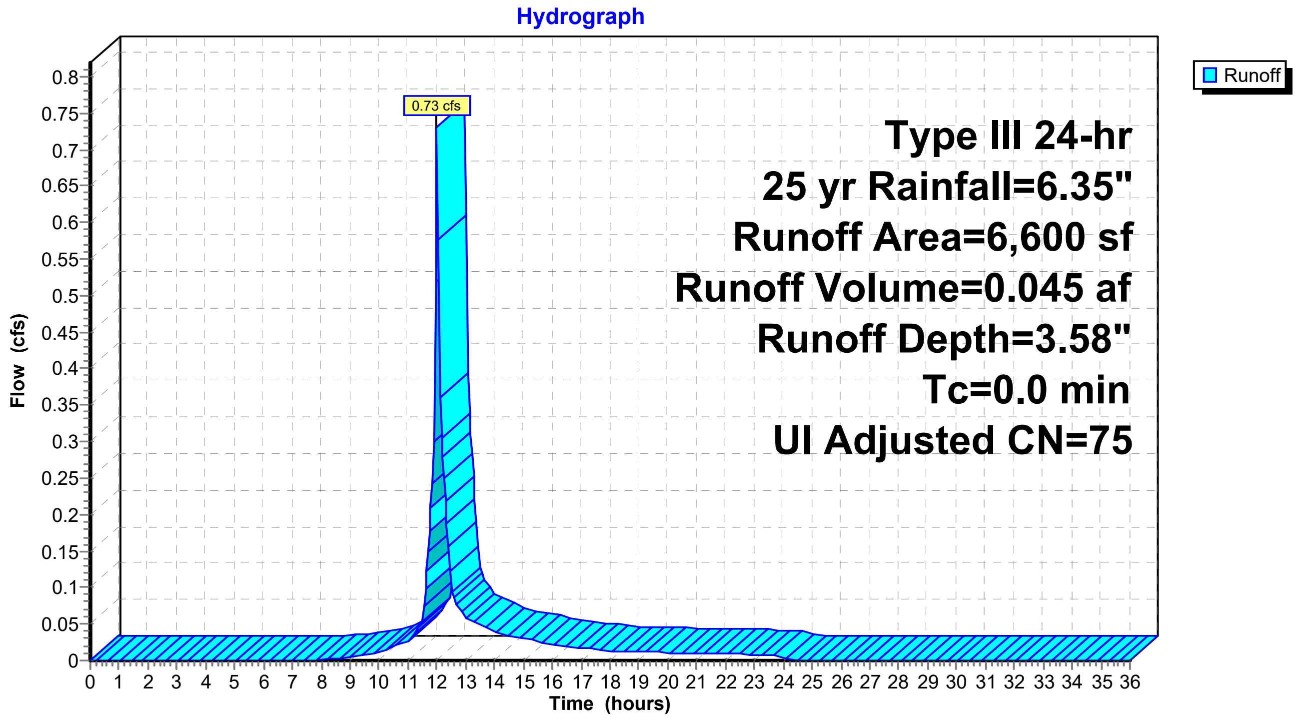
Summary for Subcatchment PR-5C: SLOPE

Runoff = 0.73 cfs @ 12.00 hrs, Volume= 0.045 af, Depth= 3.58"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=6.35"

Area (sf)	CN	Adj	Description
600	98		Unconnected roofs, HSG C
6,000	74		>75% Grass cover, Good, HSG C
6,600	76	75	Weighted Average, UI Adjusted
6,000			90.91% Pervious Area
600			9.09% Impervious Area
600			100.00% Unconnected

Subcatchment PR-5C: SLOPE



Summary for Pond 2P: rain garden#2 cascading

Inflow Area = 0.966 ac, 61.39% Impervious, Inflow Depth > 4.42" for 25 yr event
Inflow = 4.88 cfs @ 12.09 hrs, Volume= 0.356 af
Outflow = 4.87 cfs @ 12.10 hrs, Volume= 0.339 af, Atten= 0%, Lag= 0.5 min
Primary = 0.03 cfs @ 12.10 hrs, Volume= 0.049 af
Secondary = 4.85 cfs @ 12.10 hrs, Volume= 0.290 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 54.68' @ 12.10 hrs Surf.Area= 1,127 sf Storage= 1,397 cf
Flood Elev= 55.00' Surf.Area= 1,326 sf Storage= 1,784 cf

Plug-Flow detention time= 84.5 min calculated for 0.339 af (95% of inflow)
Center-of-Mass det. time= 47.9 min (883.5 - 835.6)

Volume	Invert	Avail.Storage	Storage Description
#1	51.00'	1,557 cf	**Rain Garden Envelope (Prismatic)**Listed below (Recalc) 2,357 cf Overall - 800 cf Embedded = 1,557 cf
#2	51.00'	80 cf	**crush stone (Prismatic)**Listed below (Recalc) Inside #1 200 cf Overall x 40.0% Voids
#3	51.50'	133 cf	**Bio Media (Prismatic)**Listed below (Recalc) Inside #1 532 cf Overall x 25.0% Voids
#4	52.83'	14 cf	**Mulch (Prismatic)**Listed below (Recalc) Inside #1 68 cf Overall x 20.0% Voids
		1,784 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
51.00	400	0	0
53.00	400	800	800
54.00	694	547	1,347
55.00	1,326	1,010	2,357

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
51.00	400	0	0
51.50	400	200	200

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
51.50	400	0	0
52.83	400	532	532

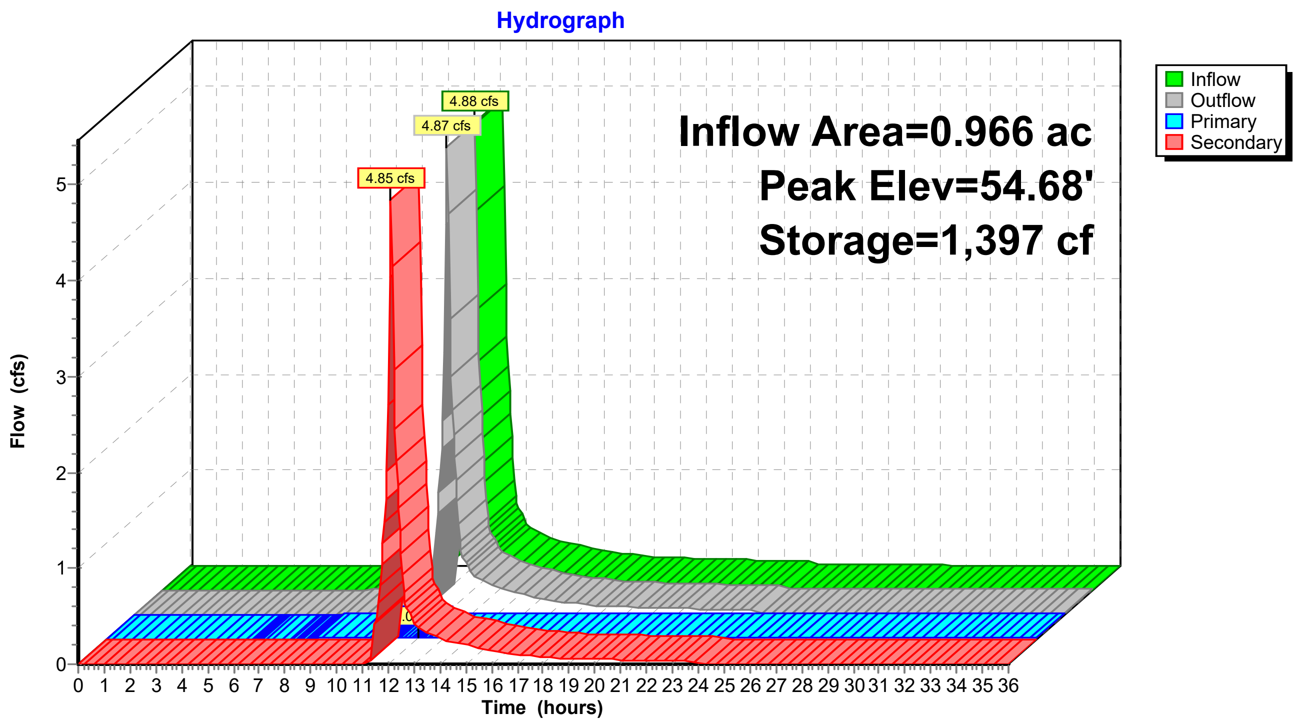
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
52.83	400	0	0
53.00	400	68	68

Device	Routing	Invert	Outlet Devices
#1	Device 3	51.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Secondary	54.50'	**25.0' long x 3.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32
#3	Primary	51.00'	**12.0" Round Culvert** L= 25.0' Ke= 0.500 Inlet / Outlet Invert= 51.00' / 50.88' S= 0.0048 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf

Primary OutFlow Max=0.03 cfs @ 12.10 hrs HW=54.68' TW=50.25' (Dynamic Tailwater)
↑—**3=Culvert** (Passes 0.03 cfs of 6.75 cfs potential flow)
  ↑—**1=Exfiltration** (Exfiltration Controls 0.03 cfs)

Secondary OutFlow Max=4.82 cfs @ 12.10 hrs HW=54.68' TW=50.25' (Dynamic Tailwater)
↑—**2=Broad-Crested Rectangular Weir** (Weir Controls 4.82 cfs @ 1.05 fps)

Pond 2P: rain garden#2 cascading



Summary for Pond 3P: rain garden#3 cascading

Inflow Area = 1.152 ac, 51.48% Impervious, Inflow Depth > 3.90" for 25 yr event
Inflow = 5.34 cfs @ 12.10 hrs, Volume= 0.374 af
Outflow = 5.15 cfs @ 12.12 hrs, Volume= 0.332 af, Atten= 4%, Lag= 0.9 min
Primary = 5.15 cfs @ 12.12 hrs, Volume= 0.332 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 50.26' @ 12.12 hrs Surf.Area= 1,539 sf Storage= 2,658 cf
Flood Elev= 50.00' Surf.Area= 1,373 sf Storage= 2,283 cf

Plug-Flow detention time= 142.8 min calculated for 0.332 af (89% of inflow)
Center-of-Mass det. time= 60.5 min (941.5 - 881.0)

Volume	Invert	Avail.Storage	Storage Description
#1	46.00'	2,710 cf	**Rain Garden Envelope (Prismatic)** Listed below (Recalc) 3,911 cf Overall - 1,200 cf Embedded = 2,710 cf
#2	46.00'	120 cf	**crush stone (Prismatic)** Listed below (Recalc) Inside #1 300 cf Overall x 40.0% Voids
#3	46.50'	199 cf	**Bio Media (Prismatic)** Listed below (Recalc) Inside #1 798 cf Overall x 25.0% Voids
#4	47.83'	20 cf	**Mulch (Prismatic)** Listed below (Recalc) Inside #1 102 cf Overall x 20.0% Voids
		3,050 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
46.00	600	0	0
48.00	600	1,200	1,200
49.00	957	779	1,979
50.00	1,373	1,165	3,144
50.50	1,695	767	3,911

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
46.00	600	0	0
46.50	600	300	300

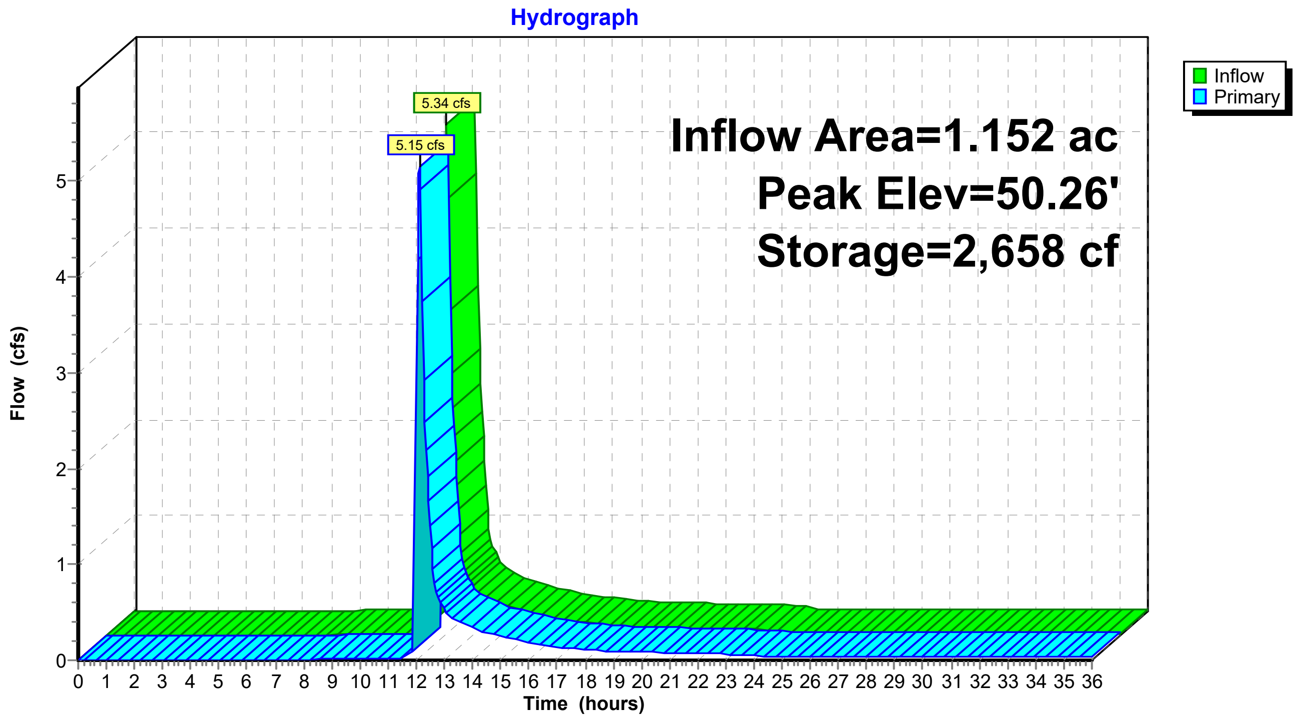
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
46.50	600	0	0
47.83	600	798	798

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
47.83	600	0	0
48.00	600	102	102

Device	Routing	Invert	Outlet Devices
#1	Device 3	46.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Device 3	50.00'	**24.0" x 48.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Primary	46.00'	**15.0" Round Culvert** L= 26.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 46.00' / 45.87' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf

Primary OutFlow Max=5.03 cfs @ 12.12 hrs HW=50.25' TW=0.00' (Dynamic Tailwater)
└─**3=Culvert** (Passes 5.03 cfs of 8.89 cfs potential flow)
  ├─**1=Exfiltration** (Exfiltration Controls 0.04 cfs)
  └─**2=Orifice/Grate** (Weir Controls 4.99 cfs @ 1.64 fps)

Pond 3P: rain garden#3 cascading



Summary for Pond 4P: UGS-1

Inflow Area =	1.705 ac, 60.59% Impervious, Inflow Depth = 4.50"	for 25 yr event	
Inflow =	8.50 cfs @ 12.09 hrs, Volume=	0.639 af	
Outflow =	8.48 cfs @ 12.10 hrs, Volume=	0.601 af,	Atten= 0%, Lag= 0.6 min
Discarded =	0.04 cfs @ 7.70 hrs, Volume=	0.103 af	
Primary =	8.44 cfs @ 12.10 hrs, Volume=	0.498 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 44.02' @ 12.10 hrs Surf.Area= 1,672 sf Storage= 4,722 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 93.7 min (889.3 - 795.6)

Volume	Invert	Avail.Storage	Storage Description
#1A	39.50'	2,099 cf	**29.92'W x 55.89'L x 5.50'H Field A**
			9,196 cf Overall - 3,198 cf Embedded = 5,998 cf x 35.0% Voids
#2A	40.25'	3,198 cf	**ADS_StormTech MC-3500 d +Cap** x 28 Inside #1
			Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf
			Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap
			28 Chambers in 4 Rows
			Cap Storage= +14.9 cf x 2 x 4 rows = 119.2 cf
		5,297 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	39.25'	**24.0" Round Culvert** L= 50.0' Ke= 0.500
			Inlet / Outlet Invert= 39.25' / 38.75' S= 0.0100 '/' Cc= 0.900
			n= 0.012, Flow Area= 3.14 sf
#2	Device 1	43.67'	**5.0' long x 4.00' rise Sharp-Crested Rectangular Weir**
			2 End Contraction(s)
#3	Discarded	39.50'	**1.020 in/hr Exfiltration over Surface area**
#4	Device 1	42.42'	**9.0" Vert. Orifice/Grate** X 3 rows with 6.0" cc spacing C= 0.600

Discarded OutFlow Max=0.04 cfs @ 7.70 hrs HW=39.59' (Free Discharge)
└─**3=Exfiltration** (Exfiltration Controls 0.04 cfs)

Primary OutFlow Max=8.41 cfs @ 12.10 hrs HW=44.02' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Passes 8.41 cfs of 29.35 cfs potential flow)
  ├─**2=Sharp-Crested Rectangular Weir** (Weir Controls 3.27 cfs @ 1.92 fps)
  └─**4=Orifice/Grate** (Orifice Controls 5.14 cfs @ 4.08 fps)

Pond 4P: UGS-1 - Chamber Wizard Field A

Chamber Model = ADS_StormTechMC-3500 d +Cap (ADS StormTech®MC-3500 d rev 03/14 with Cap volume)
Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf
Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap
Cap Storage= +14.9 cf x 2 x 4 rows = 119.2 cf

77.0" Wide + 9.0" Spacing = 86.0" C-C Row Spacing

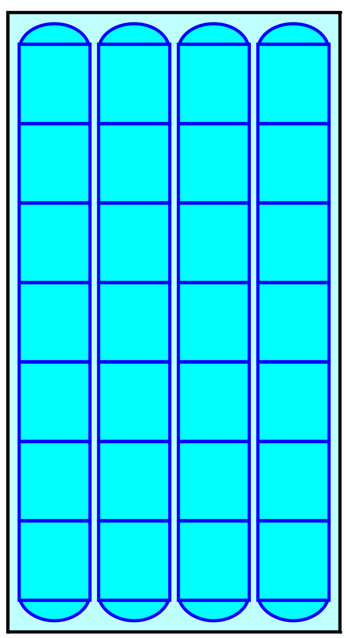
7 Chambers/Row x 7.17' Long +1.85' Cap Length x 2 = 53.89' Row Length +12.0" End Stone x 2 = 55.89' Base Length
4 Rows x 77.0" Wide + 9.0" Spacing x 3 + 12.0" Side Stone x 2 = 29.92' Base Width
9.0" Base + 45.0" Chamber Height + 12.0" Cover = 5.50' Field Height

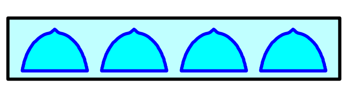
28 Chambers x 110.0 cf + 14.9 cf Cap Volume x 2 x 4 Rows = 3,197.9 cf Chamber Storage

9,196.2 cf Field - 3,197.9 cf Chambers = 5,998.4 cf Stone x 35.0% Voids = 2,099.4 cf Stone Storage

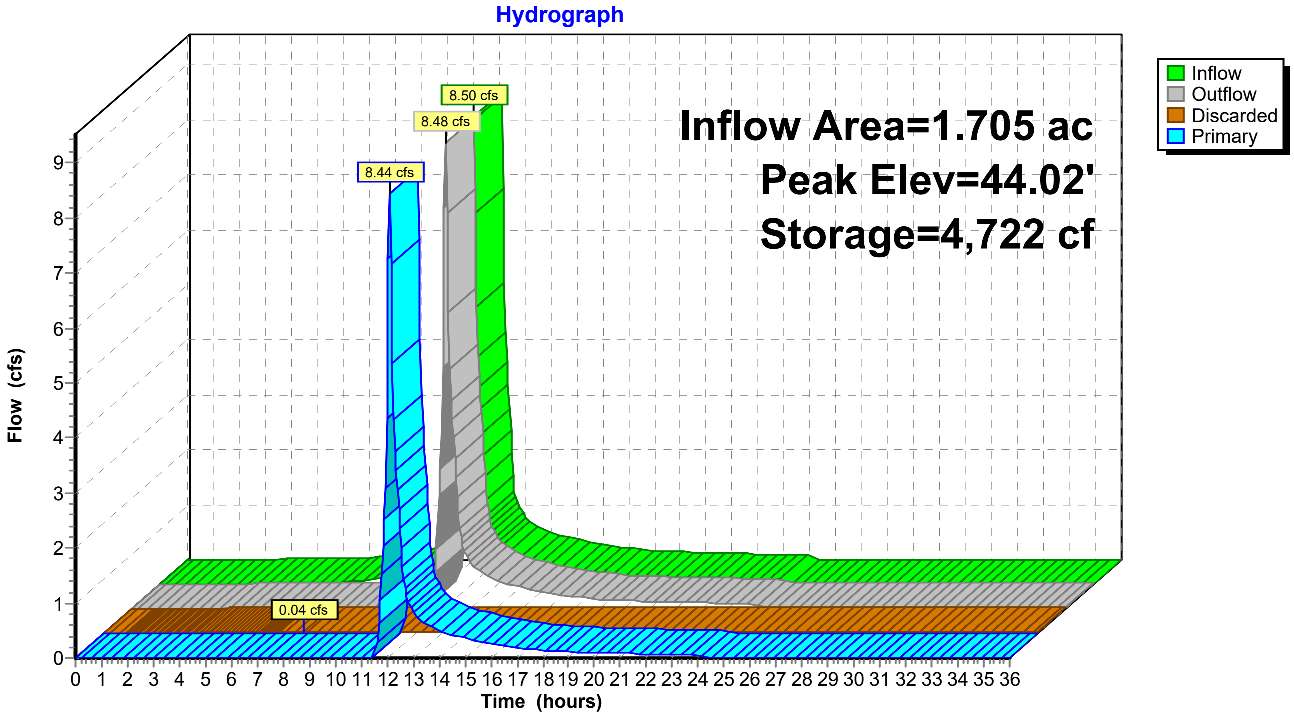
Chamber Storage + Stone Storage = 5,297.3 cf = 0.122 af
Overall Storage Efficiency = 57.6%
Overall System Size = 55.89' x 29.92' x 5.50'

28 Chambers
340.6 cy Field
222.2 cy Stone





Pond 4P: UGS-1


Hydrograph
Inflow
Outflow
Discarded
Primary
8.50 cfs
8.48 cfs
8.44 cfs
0.04 cfs
Inflow Area=1.705 ac
Peak Elev=44.02'
Storage=4,722 cf
Flow (cfs)
0
1
2
3
4
5
6
7
8
9
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36
Time (hours)

Summary for Pond 5P: rain garden#1 cascading

Inflow Area = 0.725 ac, 65.66% Impervious, Inflow Depth = 4.63" for 25 yr event
Inflow = 3.77 cfs @ 12.09 hrs, Volume= 0.280 af
Outflow = 3.78 cfs @ 12.09 hrs, Volume= 0.276 af, Atten= 0%, Lag= 0.3 min
Primary = 0.01 cfs @ 12.09 hrs, Volume= 0.025 af
Secondary = 3.77 cfs @ 12.09 hrs, Volume= 0.251 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 62.16' @ 12.09 hrs Surf.Area= 528 sf Storage= 631 cf
Flood Elev= 63.00' Surf.Area= 660 sf Storage= 1,132 cf

Plug-Flow detention time= 51.3 min calculated for 0.275 af (98% of inflow)
Center-of-Mass det. time= 43.2 min (841.7 - 798.6)

Volume	Invert	Avail.Storage	Storage Description
#1	58.50'	1,048 cf	**Rain Garden Envelope (Prismatic)** Listed below (Recalc) 1,348 cf Overall - 300 cf Embedded = 1,048 cf
#2	58.50'	30 cf	**crush stone (Prismatic)** Listed below (Recalc) Inside #1 75 cf Overall x 40.0% Voids
#3	59.00'	50 cf	**Bio Media (Prismatic)** Listed below (Recalc) Inside #1 199 cf Overall x 25.0% Voids
#4	60.33'	5 cf	**Mulch (Prismatic)** Listed below (Recalc) Inside #1 26 cf Overall x 20.0% Voids
		1,132 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
58.50	150	0	0
60.50	150	300	300
61.00	236	97	397
62.00	503	370	766
63.00	660	582	1,348

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
58.50	150	0	0
59.00	150	75	75

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
59.00	150	0	0
60.33	150	199	199

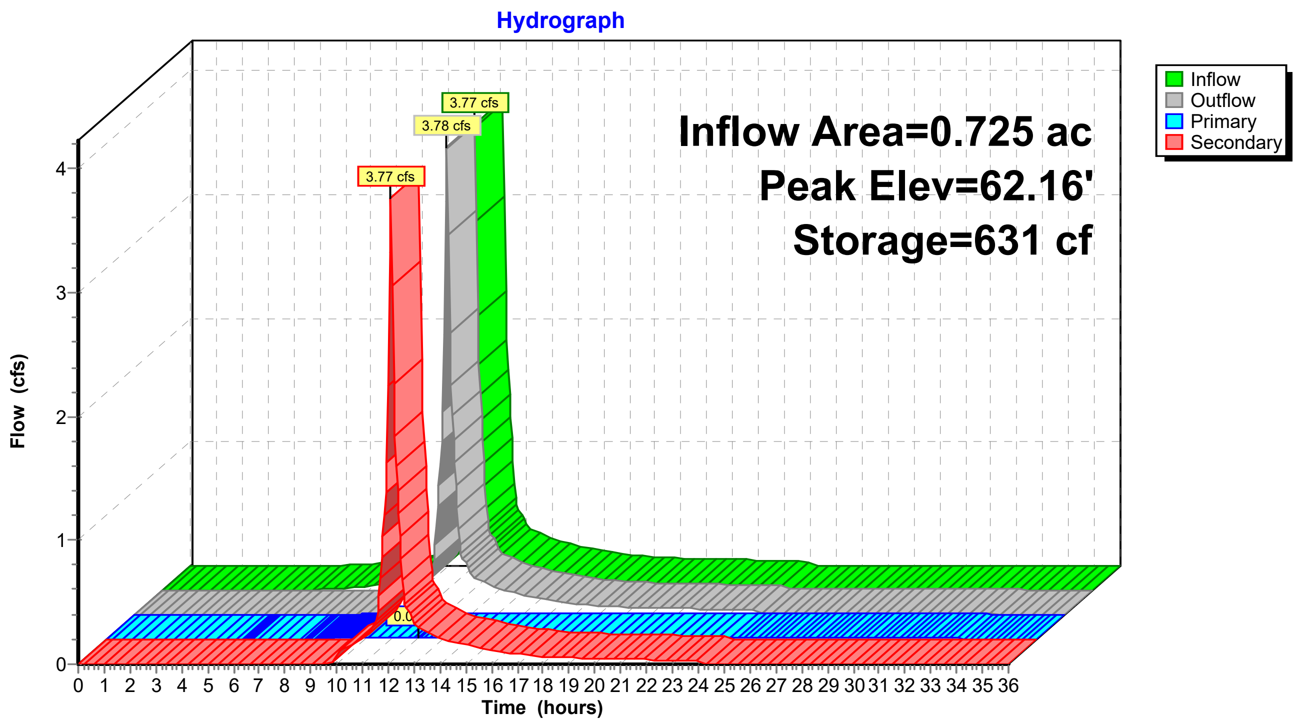
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
60.33	150	0	0
60.50	150	26	26

Device	Routing	Invert	Outlet Devices
#1	Device 3	58.50'	**1.020 in/hr Exfiltration over Surface area**
#2	Secondary	62.00'	**25.0' long x 3.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32
#3	Primary	58.50'	**8.0" Round Culvert** L= 20.0' Ke= 0.500 Inlet / Outlet Invert= 58.50' / 58.40' S= 0.0050 '/' Cc= 0.900 n= 0.012, Flow Area= 0.35 sf

Primary OutFlow Max=0.01 cfs @ 12.09 hrs HW=62.15' TW=54.68' (Dynamic Tailwater)
└─**3=Culvert** (Passes 0.01 cfs of 3.06 cfs potential flow)
  └─**1=Exfiltration** (Exfiltration Controls 0.01 cfs)

Secondary OutFlow Max=3.71 cfs @ 12.09 hrs HW=62.15' TW=54.68' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir** (Weir Controls 3.71 cfs @ 0.96 fps)

Pond 5P: rain garden#1 cascading



Summary for Pond BB 01 B: BB 01 B

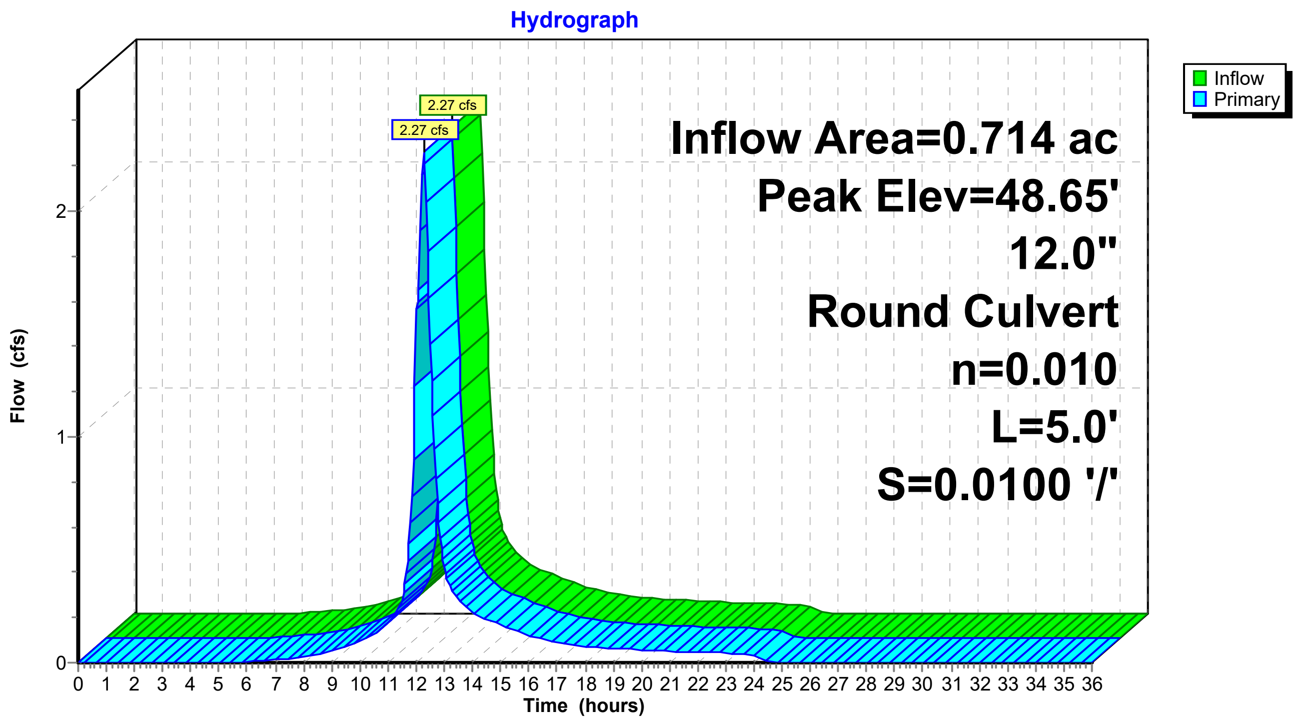
Inflow Area =	0.714 ac,	1.93% Impervious, Inflow Depth = 4.41"	for 25 yr event	
Inflow =	2.27 cfs @	12.26 hrs, Volume=	0.262 af	
Outflow =	2.27 cfs @	12.26 hrs, Volume=	0.262 af,	Atten= 0%, Lag= 0.0 min
Primary =	2.27 cfs @	12.26 hrs, Volume=	0.262 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 48.65' @ 12.26 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	47.63'	**12.0" Round Culvert** L= 5.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 47.63' / 47.58' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=2.26 cfs @ 12.26 hrs HW=48.64' TW=46.87' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 2.26 cfs @ 3.52 fps)

Pond BB 01 B: BB 01 B



Summary for Pond BB 01 S: BB 01 S

Inflow Area = 0.714 ac, 1.93% Impervious, Inflow Depth = 4.41" for 25 yr event
Inflow = 2.27 cfs @ 12.26 hrs, Volume= 0.262 af
Outflow = 0.41 cfs @ 13.02 hrs, Volume= 0.262 af, Atten= 82%, Lag= 46.0 min
Primary = 0.41 cfs @ 13.02 hrs, Volume= 0.262 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 47.20' @ 13.02 hrs Surf.Area= 0 sf Storage= 4,898 cf

Plug-Flow detention time= 192.5 min calculated for 0.262 af (100% of inflow)
Center-of-Mass det. time= 192.4 min (1,005.0 - 812.6)

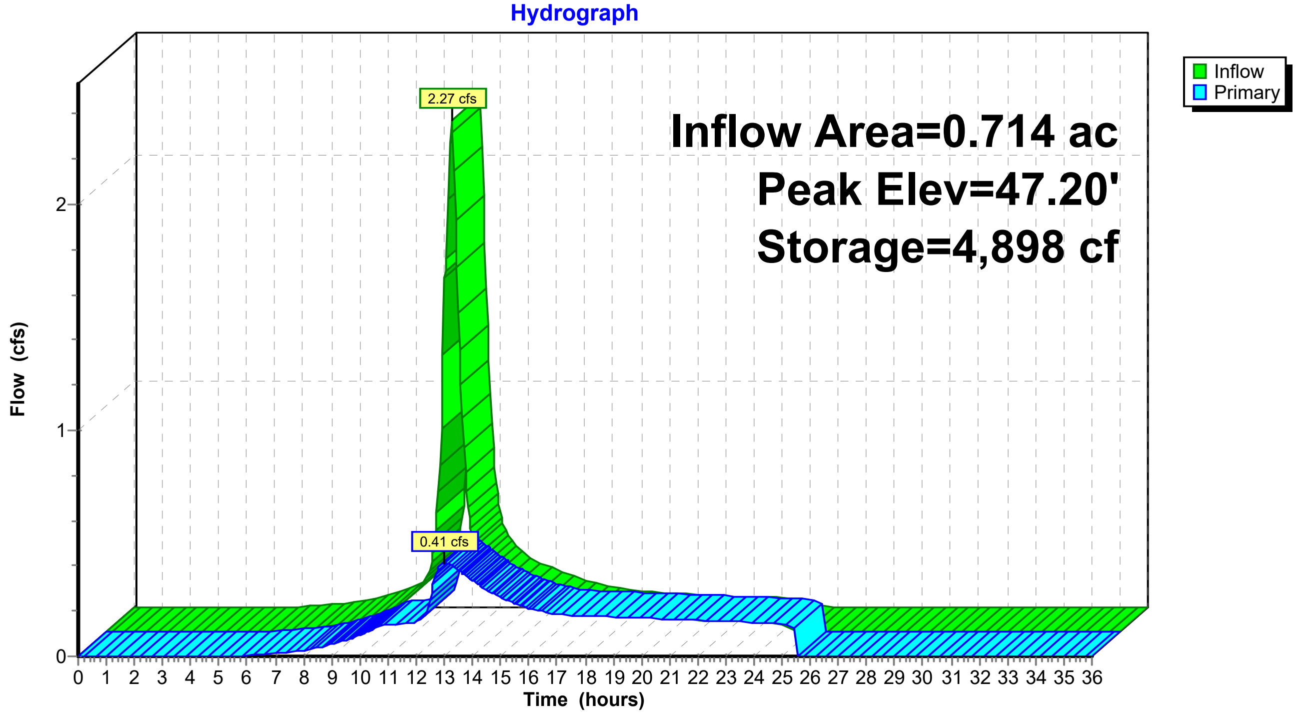
Volume	Invert	Avail.Storage	Storage Description
#1	45.65'	8,017 cf	**Custom Stage Data**Listed below

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
45.65	0	0
46.48	16	16
46.98	3,378	3,394
47.48	3,405	6,799
47.98	1,218	8,017

Device	Routing	Invert	Outlet Devices
#1	Primary	45.65'	**2.5" Vert. Orifice/Grate** C= 0.600
#2	Primary	46.98'	**4.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	46.98'	**5.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.41 cfs @ 13.02 hrs HW=47.20' TW=45.58' (Dynamic Tailwater)
├—**1=Orifice/Grate** (Orifice Controls 0.20 cfs @ 5.79 fps)
├—**2=Orifice/Grate** (Orifice Controls 0.10 cfs @ 1.60 fps)
└—**3=Orifice/Grate** (Orifice Controls 0.12 cfs @ 1.60 fps)

Pond BB 01 S: BB 01 S



Summary for Pond BB 06 B: BB 06 B

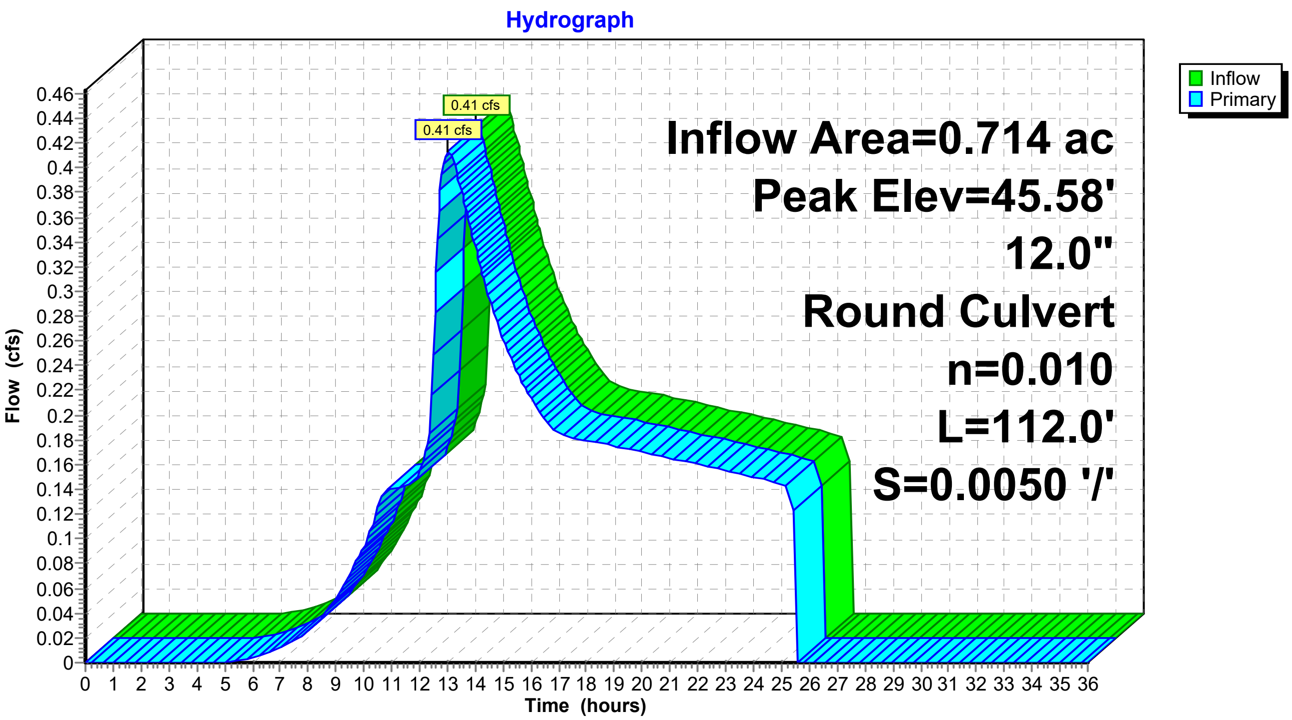
Inflow Area =	0.714 ac,	1.93% Impervious,	Inflow Depth = 4.41"	for 25 yr event
Inflow =	0.41 cfs @	13.02 hrs, Volume=	0.262 af	
Outflow =	0.41 cfs @	13.02 hrs, Volume=	0.262 af, Atten= 0%, Lag= 0.0 min	
Primary =	0.41 cfs @	13.02 hrs, Volume=	0.262 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 45.58' @ 13.02 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	45.25'	**12.0" Round Culvert** L= 112.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 45.25' / 44.69' S= 0.0050 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=0.41 cfs @ 13.02 hrs HW=45.58' TW=44.84' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 0.41 cfs @ 2.69 fps)

Pond BB 06 B: BB 06 B



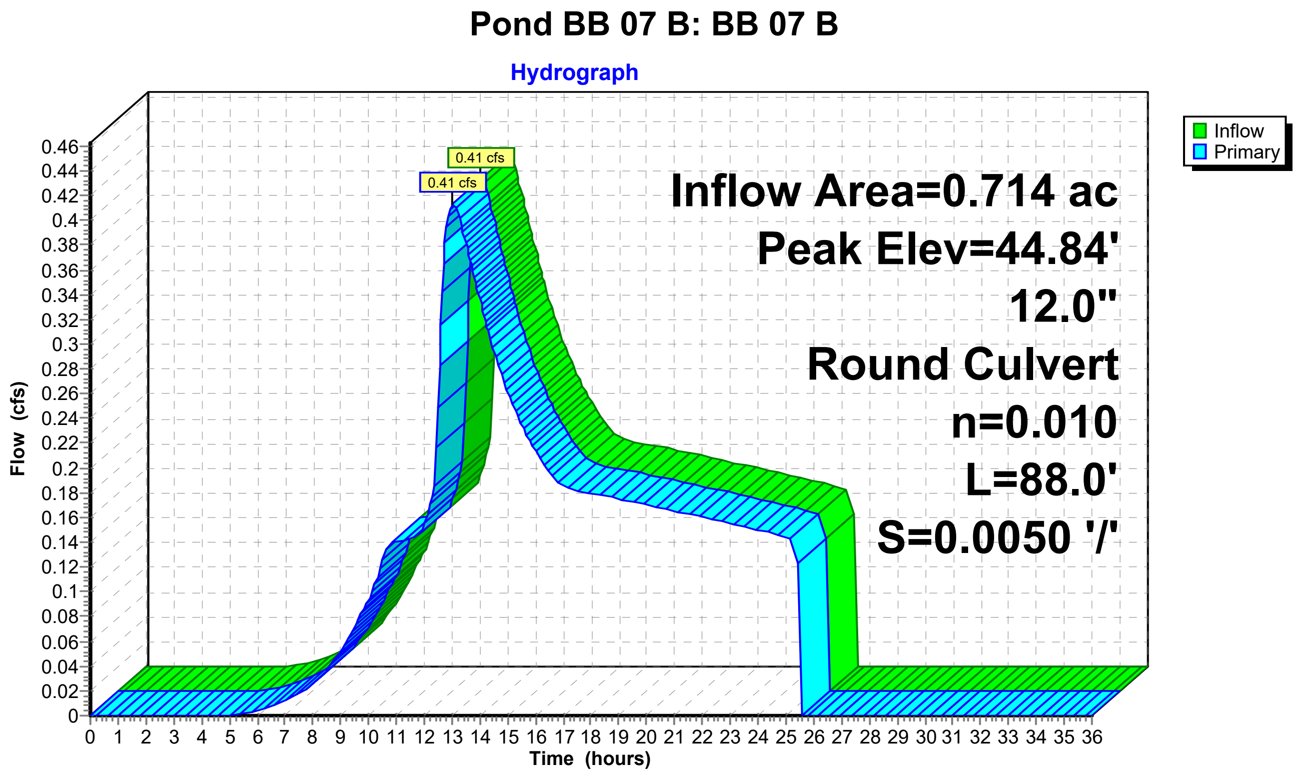
Summary for Pond BB 07 B: BB 07 B

Inflow Area =	0.714 ac,	1.93% Impervious,	Inflow Depth = 4.41"	for 25 yr event	
Inflow =	0.41 cfs @	13.02 hrs,	Volume=	0.262 af	
Outflow =	0.41 cfs @	13.02 hrs,	Volume=	0.262 af,	Atten= 0%, Lag= 0.0 min
Primary =	0.41 cfs @	13.02 hrs,	Volume=	0.262 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 44.84' @ 13.28 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	44.50'	**12.0" Round Culvert** L= 88.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 44.50' / 44.06' S= 0.0050 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=0.41 cfs @ 13.02 hrs HW=44.84' TW=44.34' (Dynamic Tailwater)
└—**1=Culvert** (Outlet Controls 0.41 cfs @ 2.60 fps)



Summary for Pond BB 11 B: BB 11 B

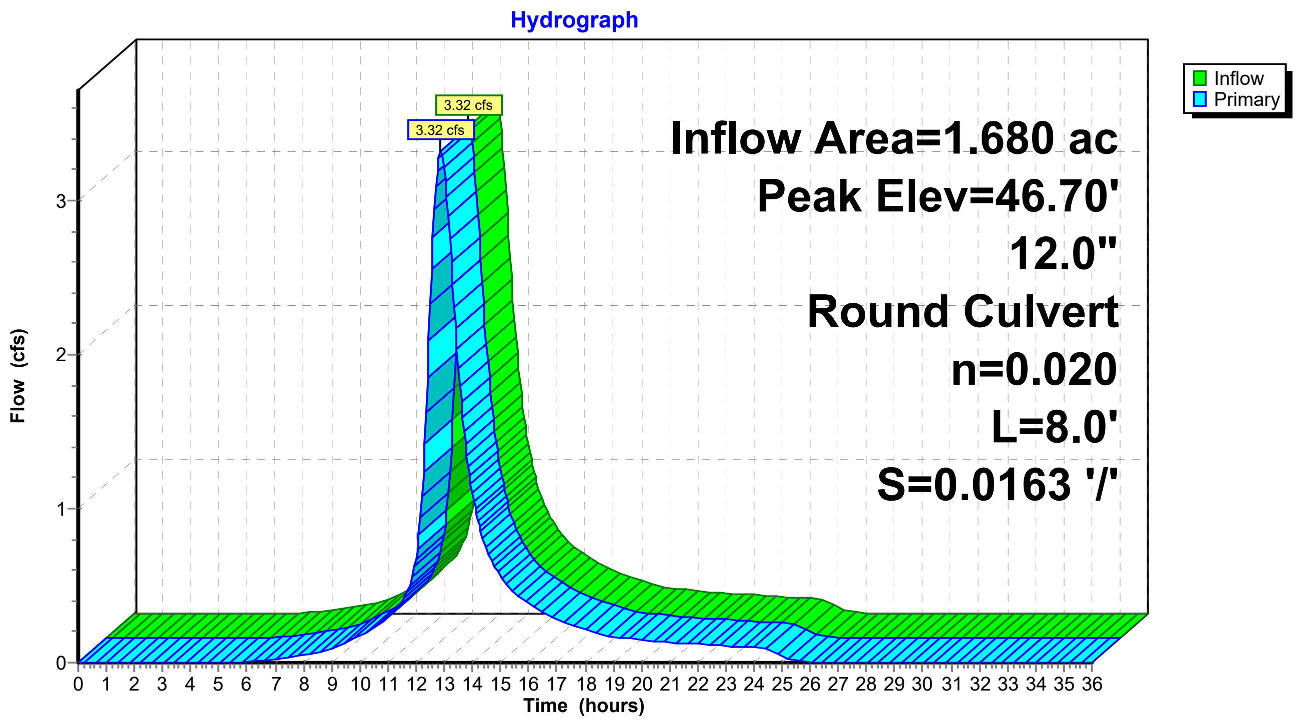
Inflow Area =	1.680 ac,	0.00% Impervious, Inflow Depth = 4.63"	for 25 yr event	
Inflow =	3.32 cfs @	12.87 hrs, Volume=	0.649 af	
Outflow =	3.32 cfs @	12.87 hrs, Volume=	0.649 af,	Atten= 0%, Lag= 0.0 min
Primary =	3.32 cfs @	12.87 hrs, Volume=	0.649 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 46.70' @ 12.87 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	45.25'	**12.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 45.25' / 45.12' S= 0.0163 '/' Cc= 0.900 n= 0.020, Flow Area= 0.79 sf

Primary OutFlow Max=3.32 cfs @ 12.87 hrs HW=46.70' TW=45.45' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 3.32 cfs @ 4.22 fps)

Pond BB 11 B: BB 11 B



Summary for Pond BB 11 S: BB 11 S

Inflow Area = 1.680 ac, 0.00% Impervious, Inflow Depth = 4.63" for 25 yr event
Inflow = 3.32 cfs @ 12.87 hrs, Volume= 0.649 af
Outflow = 2.06 cfs @ 13.44 hrs, Volume= 0.649 af, Atten= 38%, Lag= 34.4 min
Primary = 2.06 cfs @ 13.44 hrs, Volume= 0.649 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 45.77' @ 13.44 hrs Surf.Area= 0 sf Storage= 5,009 cf

Plug-Flow detention time= 20.3 min calculated for 0.649 af (100% of inflow)
Center-of-Mass det. time= 19.9 min (874.9 - 855.0)

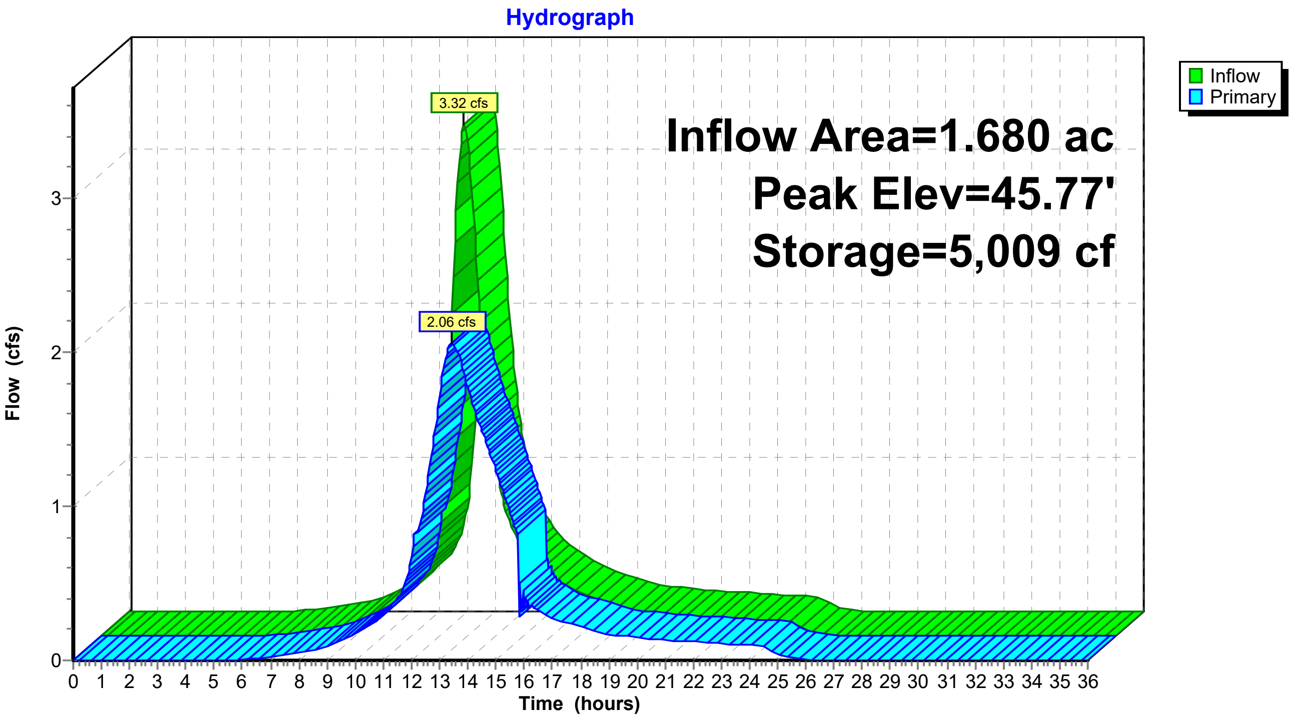
Volume	Invert	Avail.Storage	Storage Description
#1	44.14'	7,432 cf	**Custom Stage Data** Listed below

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
44.14	0	0
44.97	16	16
45.47	3,131	3,147
45.97	3,156	6,303
46.47	1,129	7,432

Device	Routing	Invert	Outlet Devices
#1	Primary	44.14'	**2.5" Vert. Orifice/Grate** C= 0.600
#2	Primary	44.47'	**8.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	45.47'	**6.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=2.06 cfs @ 13.44 hrs HW=45.76' TW=44.41' (Dynamic Tailwater)
1=Orifice/Grate (Orifice Controls 0.19 cfs @ 5.61 fps)
2=Orifice/Grate (Orifice Controls 1.65 cfs @ 4.72 fps)
3=Orifice/Grate (Orifice Controls 0.22 cfs @ 1.85 fps)

Pond BB 11 S: BB 11 S



Summary for Pond PR-4: SB 01 DMH

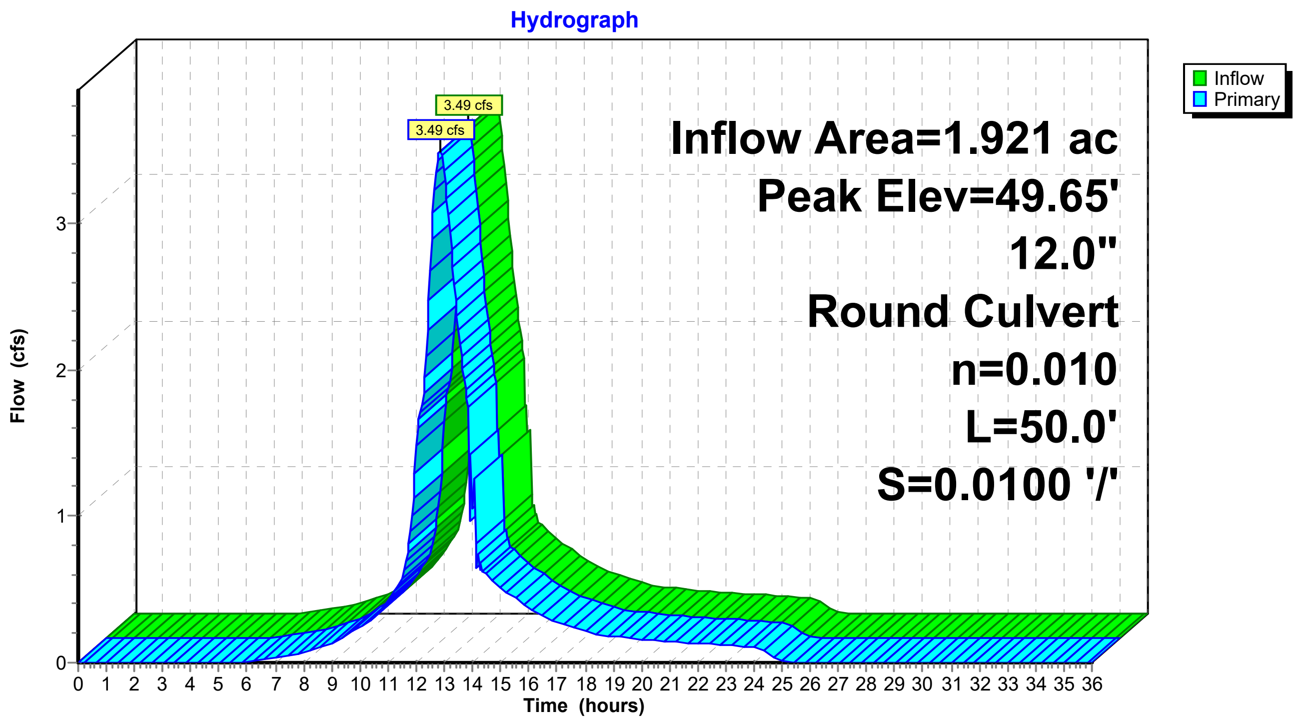
Inflow Area = 1.921 ac, 1.31% Impervious, Inflow Depth = 4.59" for 25 yr event
Inflow = 3.49 cfs @ 12.84 hrs, Volume= 0.734 af
Outflow = 3.49 cfs @ 12.84 hrs, Volume= 0.734 af, Atten= 0%, Lag= 0.0 min
Primary = 3.49 cfs @ 12.84 hrs, Volume= 0.734 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 49.65' @ 12.84 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	48.30'	**12.0" Round Culvert** L= 50.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 48.30' / 47.80' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=3.49 cfs @ 12.84 hrs HW=49.65' TW=0.00' (Dynamic Tailwater)
1=Culvert (Inlet Controls 3.49 cfs @ 4.44 fps)

Pond PR-4: SB 01 DMH



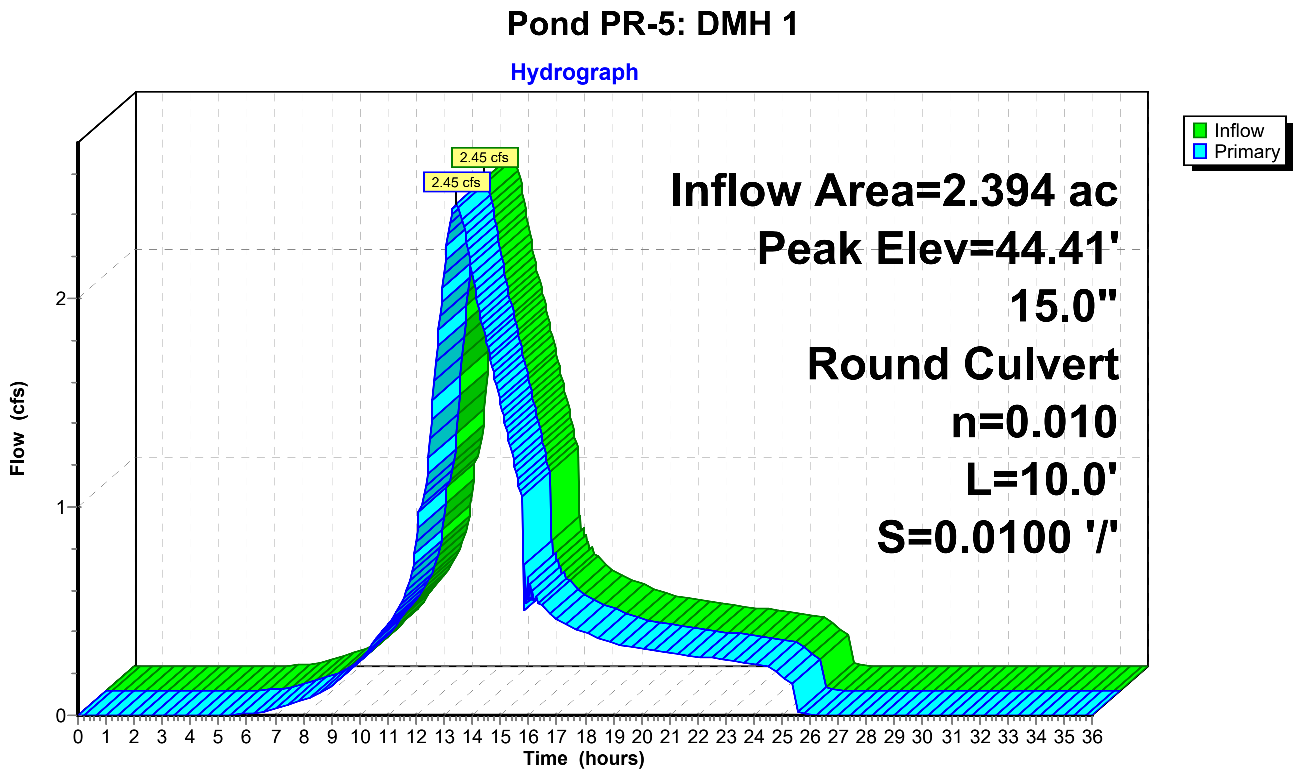
Summary for Pond PR-5: DMH 1

Inflow Area = 2.394 ac, 0.58% Impervious, Inflow Depth = 4.57" for 25 yr event
Inflow = 2.45 cfs @ 13.41 hrs, Volume= 0.911 af
Outflow = 2.45 cfs @ 13.41 hrs, Volume= 0.911 af, Atten= 0%, Lag= 0.0 min
Primary = 2.45 cfs @ 13.41 hrs, Volume= 0.911 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 44.41' @ 13.41 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	43.50'	**15.0" Round Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 43.50' / 43.40' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 1.23 sf

Primary OutFlow Max=2.45 cfs @ 13.41 hrs HW=44.41' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Barrel Controls 2.45 cfs @ 3.59 fps)



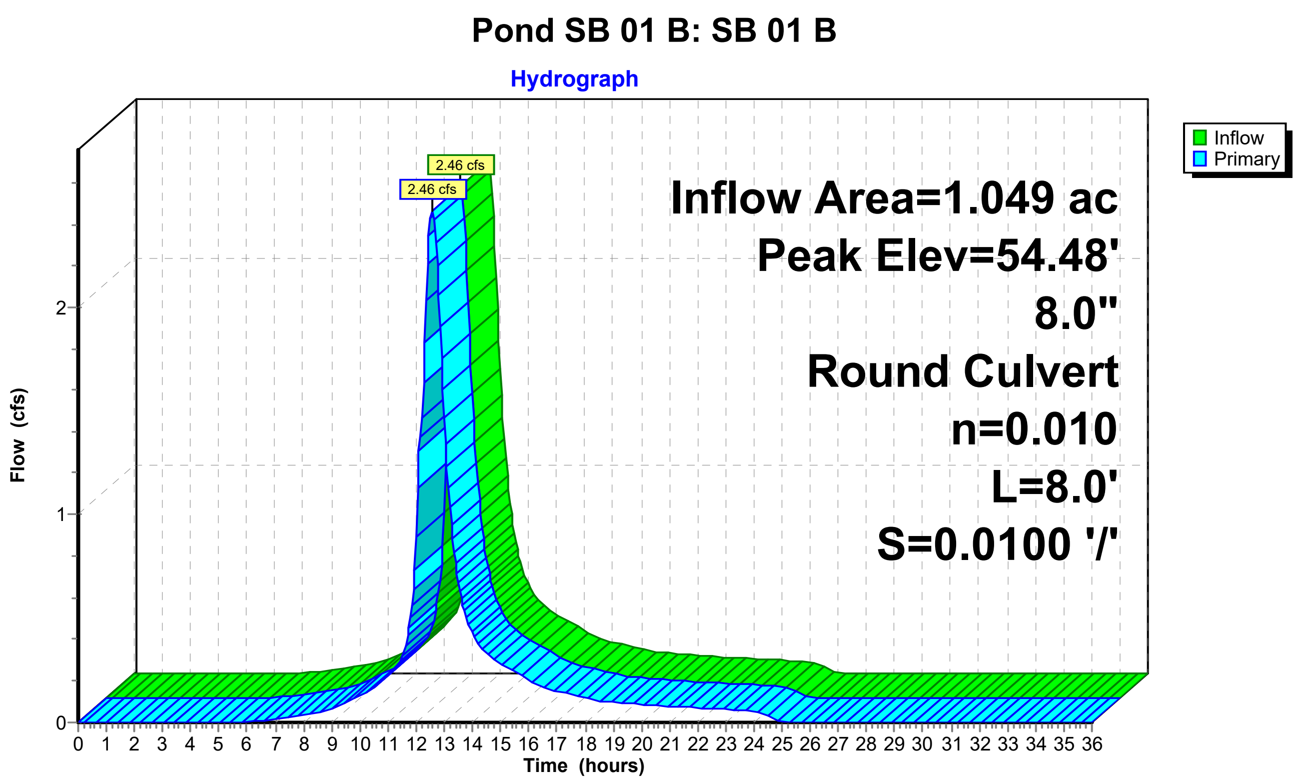
Summary for Pond SB 01 B: SB 01 B

Inflow Area =	1.049 ac,	2.41% Impervious,	Inflow Depth = 4.55"	for 25 yr event
Inflow =	2.46 cfs @	12.56 hrs, Volume=	0.397 af	
Outflow =	2.46 cfs @	12.56 hrs, Volume=	0.397 af,	Atten= 0%, Lag= 0.0 min
Primary =	2.46 cfs @	12.56 hrs, Volume=	0.397 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 54.48' @ 12.56 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	52.00'	**8.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 52.00' / 51.92' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.35 sf

Primary OutFlow Max=2.46 cfs @ 12.56 hrs HW=54.47' TW=51.81' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 2.46 cfs @ 7.04 fps)



Summary for Pond SB 01 S: SB 01 S

Inflow Area = 1.049 ac, 2.41% Impervious, Inflow Depth = 4.55" for 25 yr event
Inflow = 2.46 cfs @ 12.56 hrs, Volume= 0.397 af
Outflow = 1.86 cfs @ 12.86 hrs, Volume= 0.397 af, Atten= 25%, Lag= 18.3 min
Primary = 1.86 cfs @ 12.86 hrs, Volume= 0.397 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 51.94' @ 12.87 hrs Surf.Area= 0 sf Storage= 2,047 cf

Plug-Flow detention time= 8.4 min calculated for 0.397 af (100% of inflow)
Center-of-Mass det. time= 8.0 min (839.9 - 832.0)

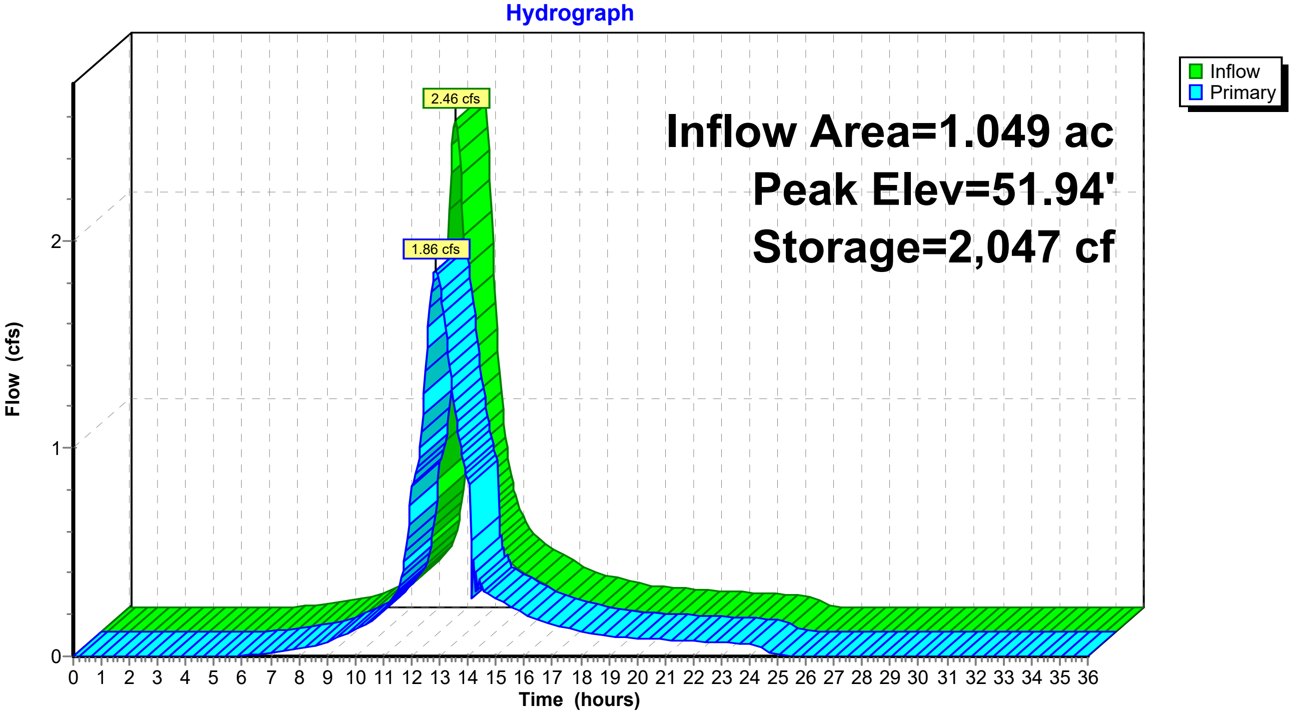
Volume	Invert	Avail.Storage	Storage Description
#1	50.64'	3,084 cf	**Custom Stage Data** Listed below

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
50.64	0	0
51.47	16	16
51.97	2,170	2,186
52.47	898	3,084

Device	Routing	Invert	Outlet Devices
#1	Primary	50.64'	**4.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	50.97'	**6.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	51.47'	**8.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=1.85 cfs @ 12.86 hrs HW=51.94' TW=50.81' (Dynamic Tailwater)
├─**1=Orifice/Grate** (Orifice Controls 0.45 cfs @ 5.11 fps)
├─**2=Orifice/Grate** (Orifice Controls 0.80 cfs @ 4.08 fps)
└─**3=Orifice/Grate** (Orifice Controls 0.61 cfs @ 2.33 fps)

Pond SB 01 S: SB 01 S



Summary for Pond SB 02 B: SB 02 B

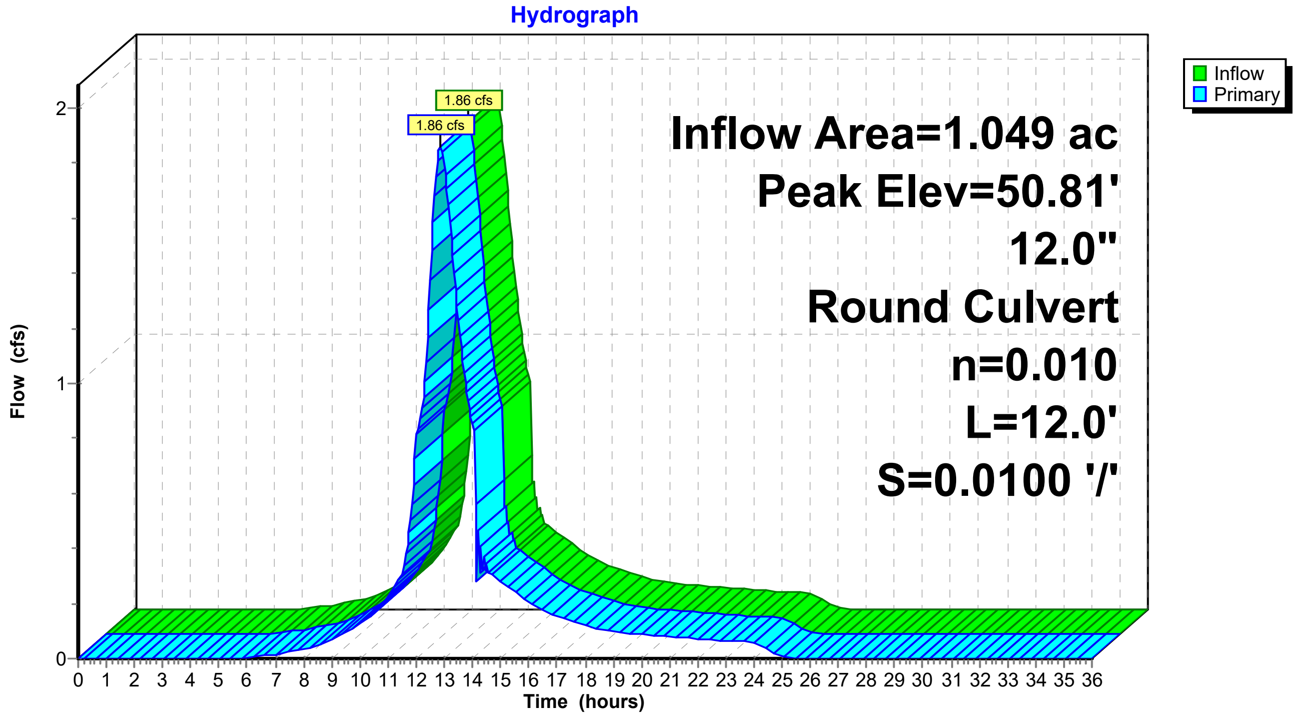
Inflow Area =	1.049 ac,	2.41% Impervious,	Inflow Depth = 4.55"	for 25 yr event	
Inflow =	1.86 cfs @	12.86 hrs,	Volume=	0.397 af	
Outflow =	1.86 cfs @	12.86 hrs,	Volume=	0.397 af,	Atten= 0%, Lag= 0.0 min
Primary =	1.86 cfs @	12.86 hrs,	Volume=	0.397 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 50.81' @ 12.86 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	49.97'	**12.0" Round Culvert** L= 12.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 49.97' / 49.85' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=1.86 cfs @ 12.86 hrs HW=50.81' TW=49.65' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 1.86 cfs @ 3.55 fps)

Pond SB 02 B: SB 02 B



Summary for Pond SB 11 B: SB 11 B

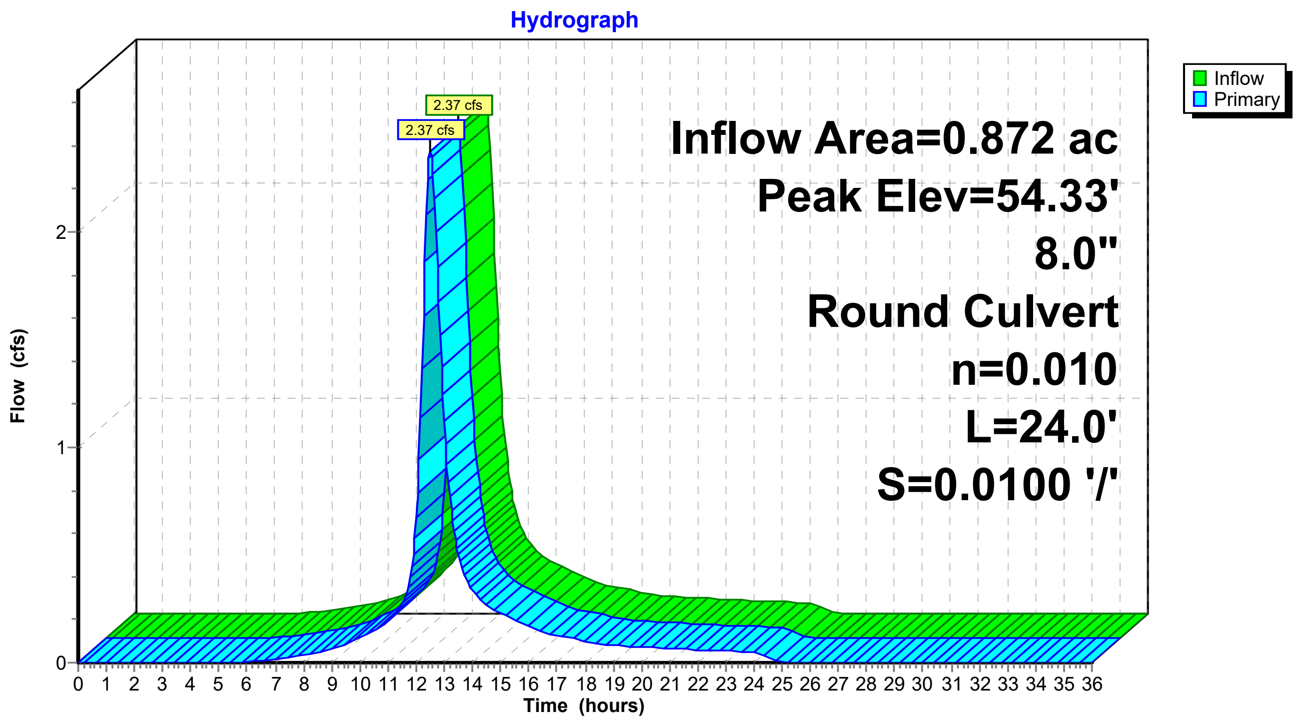
Inflow Area = 0.872 ac, 0.00% Impervious, Inflow Depth = 4.63" for 25 yr event
Inflow = 2.37 cfs @ 12.50 hrs, Volume= 0.337 af
Outflow = 2.37 cfs @ 12.50 hrs, Volume= 0.337 af, Atten= 0%, Lag= 0.0 min
Primary = 2.37 cfs @ 12.50 hrs, Volume= 0.337 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 54.33' @ 12.50 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	52.00'	**8.0" Round Culvert** L= 24.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 52.00' / 51.76' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.35 sf

Primary OutFlow Max=2.37 cfs @ 12.50 hrs HW=54.32' TW=51.96' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 2.37 cfs @ 6.79 fps)

Pond SB 11 B: SB 11 B



Summary for Pond SB 11 S: SB 11 S

Inflow Area = 0.872 ac, 0.00% Impervious, Inflow Depth = 4.63" for 25 yr event
Inflow = 2.37 cfs @ 12.50 hrs, Volume= 0.337 af
Outflow = 1.64 cfs @ 12.81 hrs, Volume= 0.337 af, Atten= 31%, Lag= 18.6 min
Primary = 1.64 cfs @ 12.81 hrs, Volume= 0.337 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 52.11' @ 12.81 hrs Surf.Area= 0 sf Storage= 1,803 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 7.3 min (834.9 - 827.7)

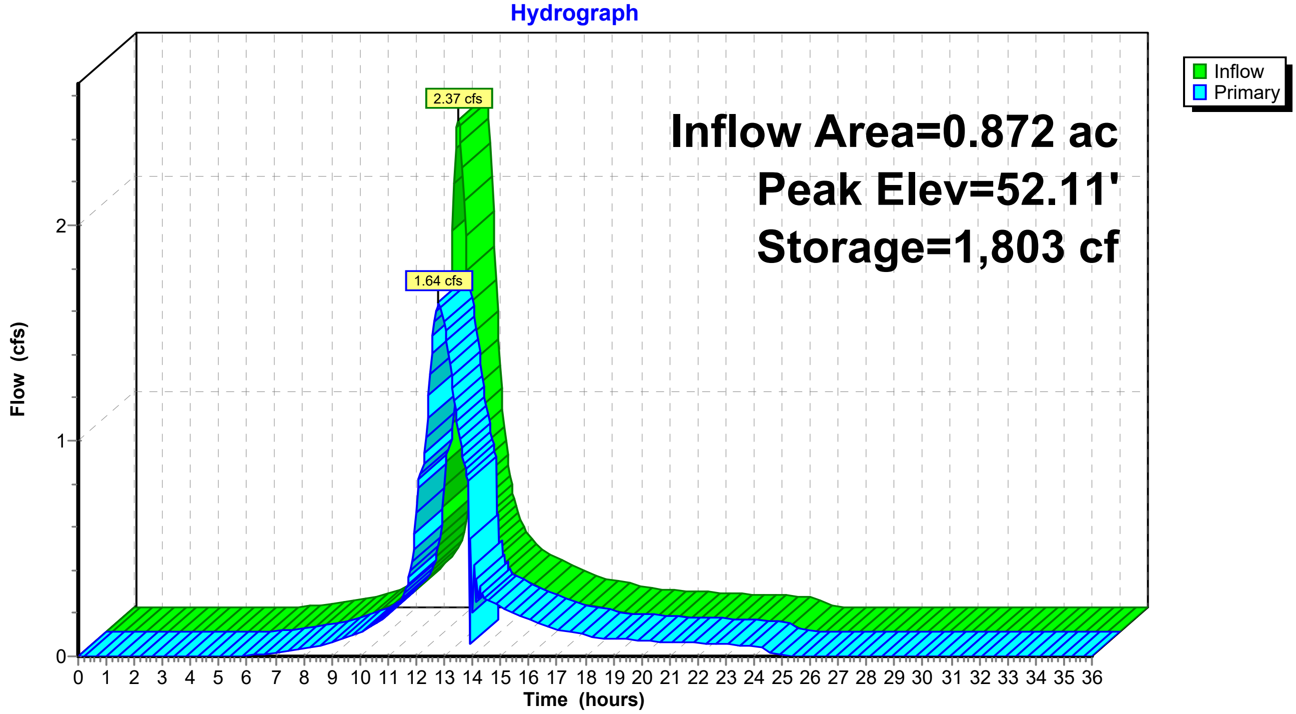
Volume	Invert	Avail.Storage	Storage Description
#1	50.84'	2,892 cf	**Custom Stage Data** Listed below

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
50.84	0	0
51.67	16	16
52.17	2,035	2,051
52.67	841	2,892

Device	Routing	Invert	Outlet Devices
#1	Primary	50.84'	**4.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	51.17'	**6.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	51.67'	**6.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=1.64 cfs @ 12.81 hrs HW=52.11' TW=50.86' (Dynamic Tailwater)
├─**1=Orifice/Grate** (Orifice Controls 0.44 cfs @ 5.05 fps)
├─**2=Orifice/Grate** (Orifice Controls 0.78 cfs @ 3.99 fps)
└─**3=Orifice/Grate** (Orifice Controls 0.41 cfs @ 2.25 fps)

Pond SB 11 S: SB 11 S



Summary for Pond SB 12 B: SB 12 B

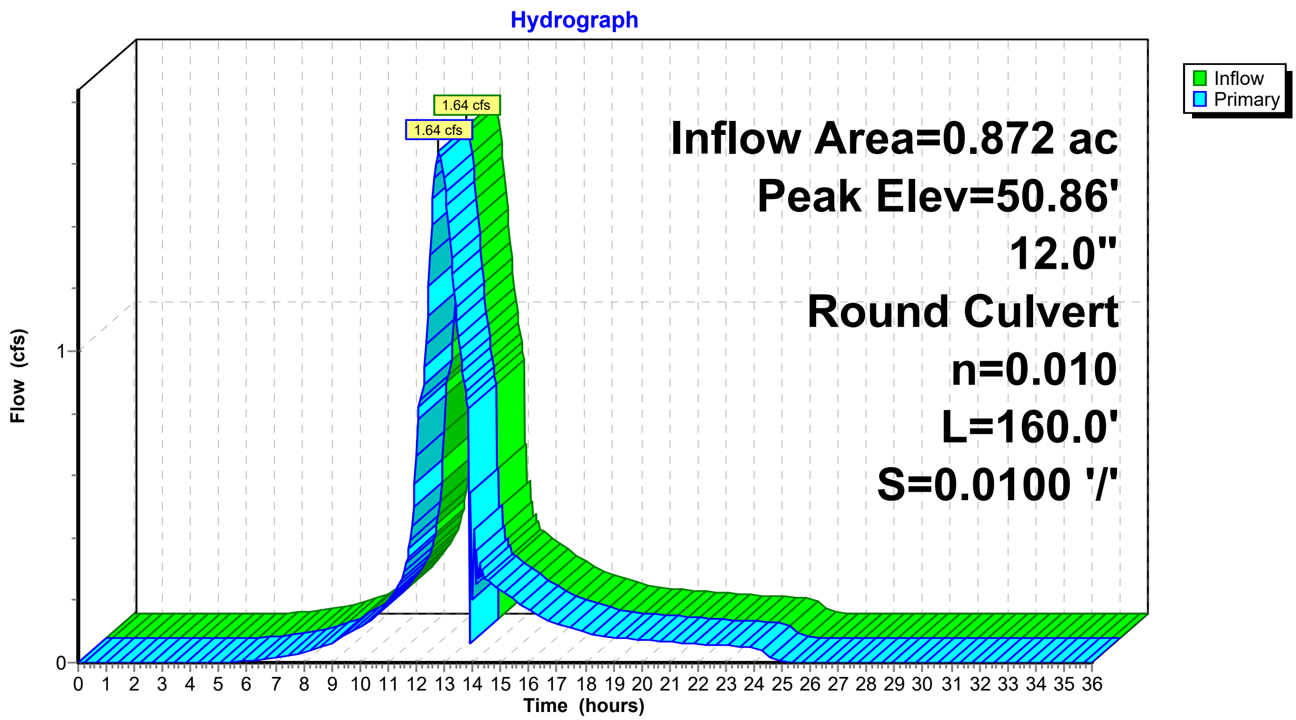
Inflow Area =	0.872 ac,	0.00% Impervious,	Inflow Depth =	4.63"	for 25 yr event
Inflow =	1.64 cfs @	12.81 hrs,	Volume=	0.337 af	
Outflow =	1.64 cfs @	12.81 hrs,	Volume=	0.337 af,	Atten= 0%, Lag= 0.0 min
Primary =	1.64 cfs @	12.81 hrs,	Volume=	0.337 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 50.86' @ 12.81 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	50.17'	**12.0" Round Culvert** L= 160.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 50.17' / 48.57' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=1.64 cfs @ 12.81 hrs HW=50.86' TW=49.65' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 1.64 cfs @ 2.83 fps)

Pond SB 12 B: SB 12 B

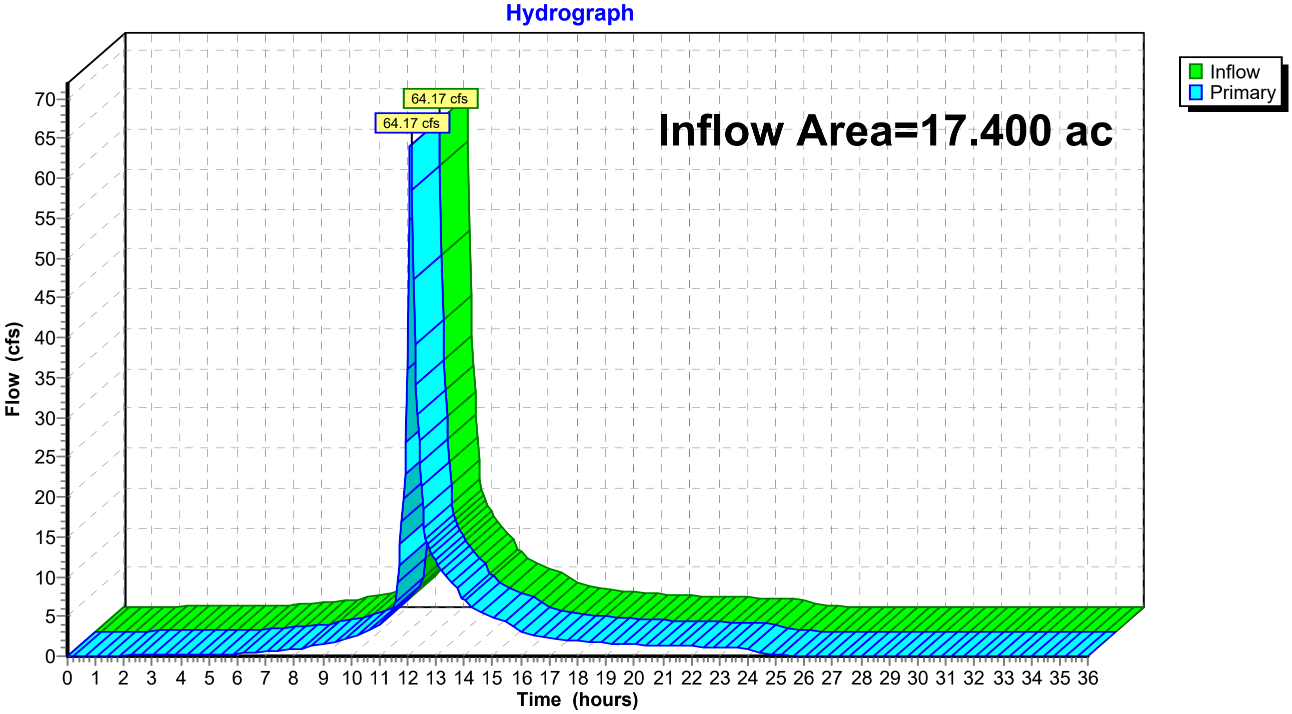


Summary for Link POA: POA

Inflow Area =	17.400 ac,	49.60% Impervious,	Inflow Depth > 4.52"	for 25 yr event
Inflow =	64.17 cfs @	12.11 hrs, Volume=	6.559 af	
Primary =	64.17 cfs @	12.11 hrs, Volume=	6.559 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Link POA: POA



Summary for Subcatchment PR-1: PR-1

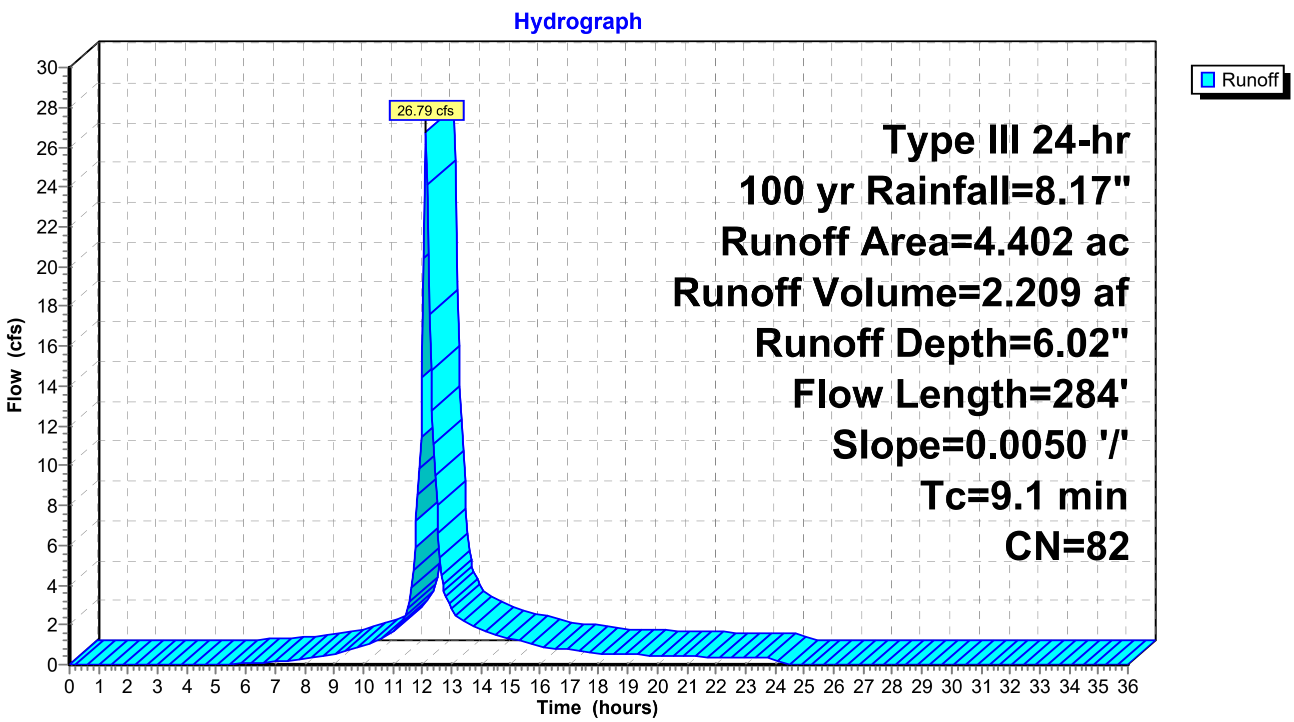
Runoff = 26.79 cfs @ 12.13 hrs, Volume= 2.209 af, Depth= 6.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.17"

Area (ac)	CN	Description
1.892	61	>75% Grass cover, Good, HSG B
2.510	98	Paved parking, HSG B
4.402	82	Weighted Average
1.892		42.98% Pervious Area
2.510		57.02% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	50	0.0050	0.69		**Sheet Flow, A-B** Smooth surfaces n= 0.011 P2= 3.20"
7.9	234	0.0050	0.49		**Shallow Concentrated Flow, B-C** Short Grass Pasture Kv= 7.0 fps
9.1	284	Total			

Subcatchment PR-1: PR-1



Summary for Subcatchment PR-1A: PR-1A

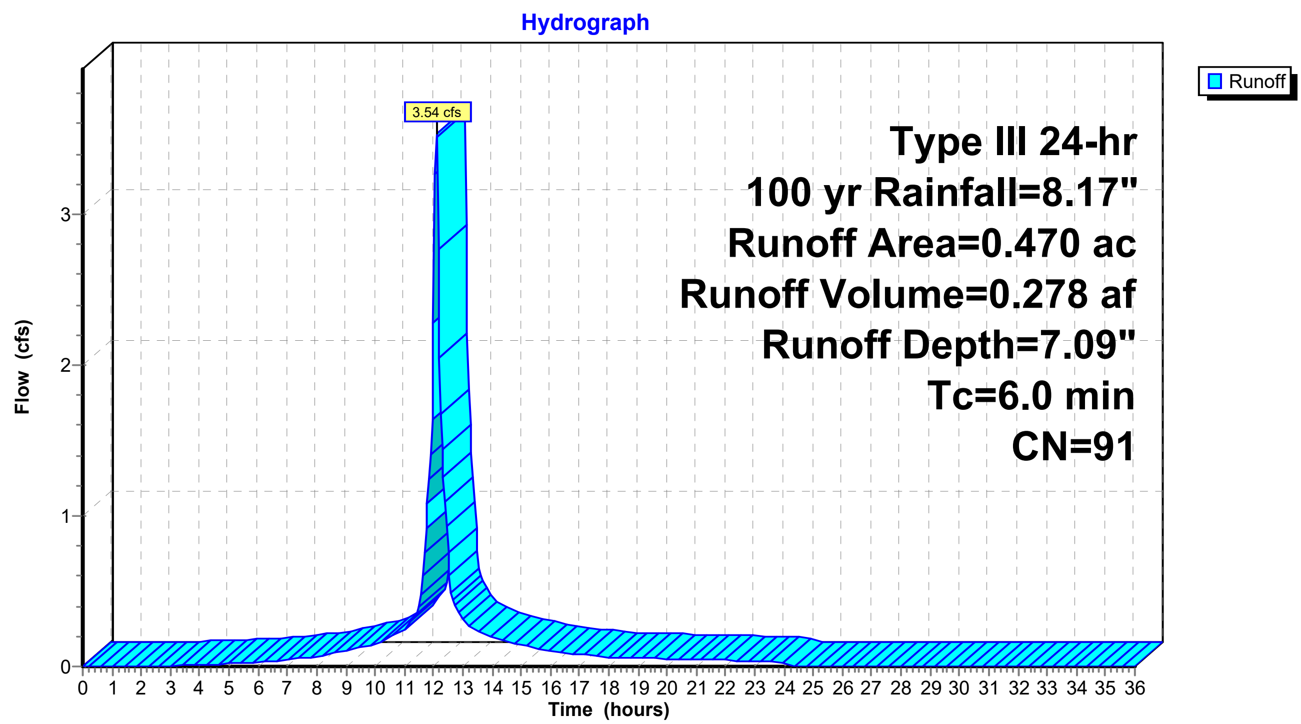
Runoff = 3.54 cfs @ 12.09 hrs, Volume= 0.278 af, Depth= 7.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.17"

Area (ac)	CN	Description
0.090	61	>75% Grass cover, Good, HSG B
0.380	98	Paved parking, HSG B
0.470	91	Weighted Average
0.090		19.15% Pervious Area
0.380		80.85% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-1A: PR-1A



Summary for Subcatchment PR-1B: PR-1B

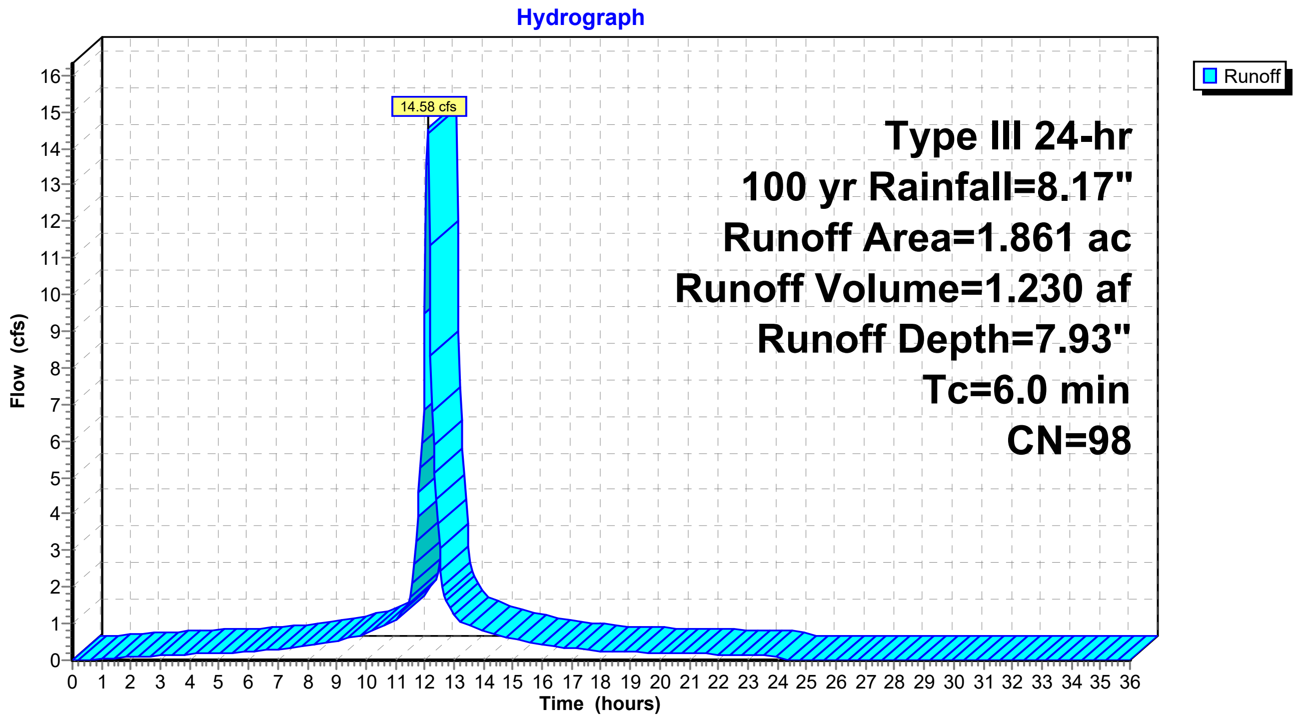
Runoff = 14.58 cfs @ 12.09 hrs, Volume= 1.230 af, Depth= 7.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.17"

Area (ac)	CN	Description
1.861	98	Roofs, HSG B
1.861		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-1B: PR-1B



Summary for Subcatchment PR-1C: PR-1C

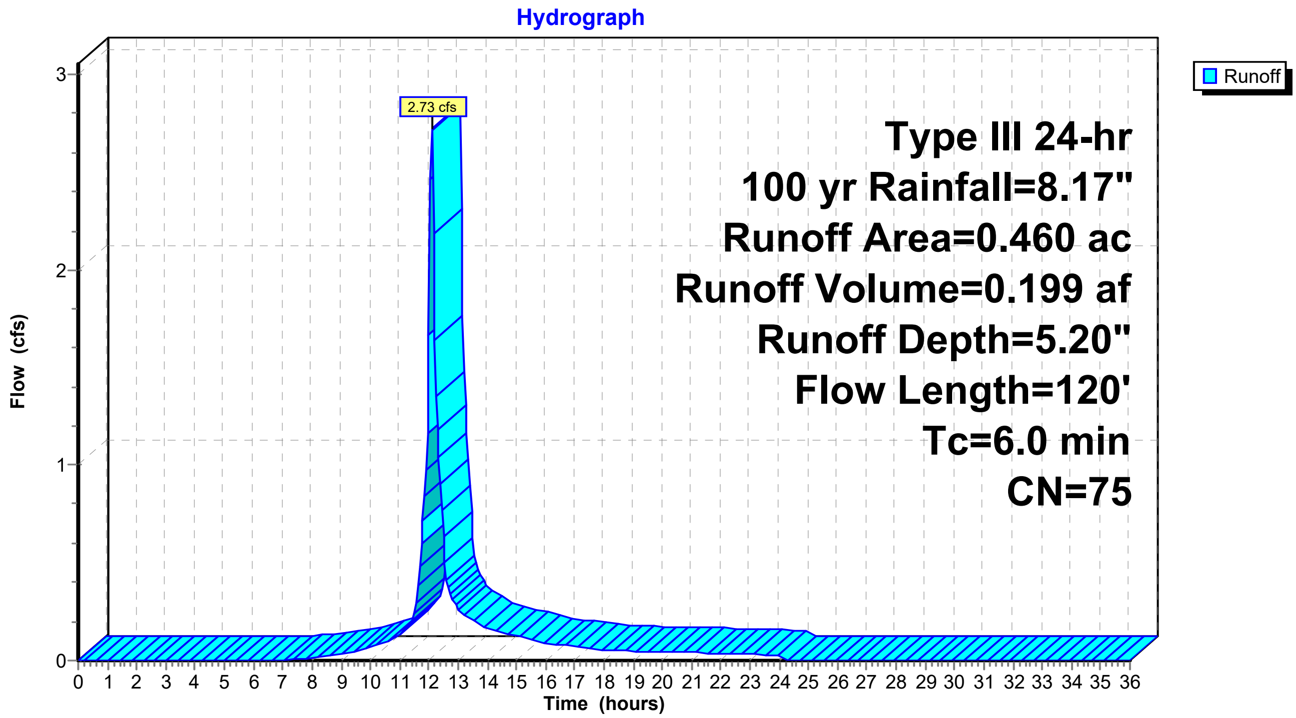
Runoff = 2.73 cfs @ 12.09 hrs, Volume= 0.199 af, Depth= 5.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.17"

Area (ac)	CN	Description
0.020	55	Woods, Good, HSG B
0.260	61	>75% Grass cover, Good, HSG B
0.180	98	Paved parking, HSG B
0.460	75	Weighted Average
0.280		60.87% Pervious Area
0.180		39.13% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	20	0.0700	0.09		**Sheet Flow, 20' SF** Woods: Light underbrush n= 0.400 P2= 3.20"
1.9	40	0.5000	0.35		**Sheet Flow, 30' SF** Grass: Dense n= 0.240 P2= 3.20"
0.1	12	0.0100	1.61		**Shallow Concentrated Flow, 12' SCF** Unpaved Kv= 16.1 fps
0.2	48	0.0400	4.06		**Shallow Concentrated Flow, 48' SCF** Paved Kv= 20.3 fps
5.8	120	Total, Increased to minimum Tc = 6.0 min			

Subcatchment PR-1C: PR-1C



Summary for Subcatchment PR-1D: PR-1D

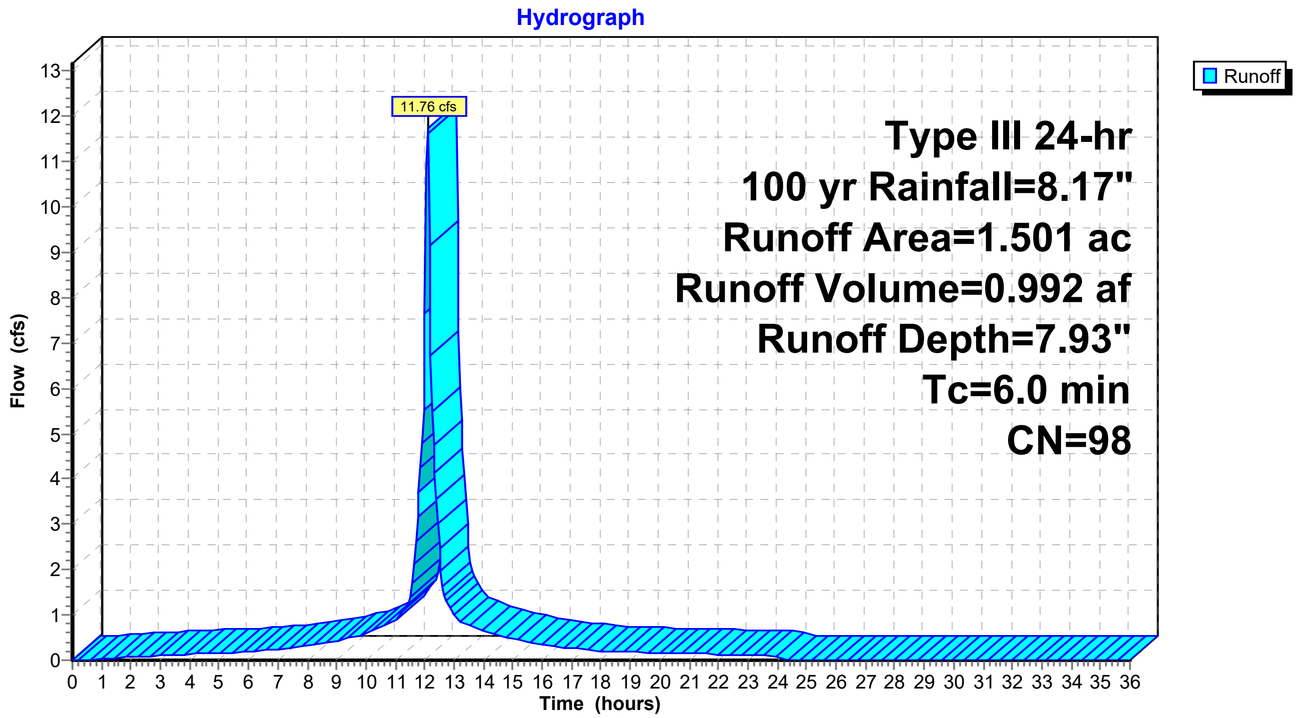
Runoff = 11.76 cfs @ 12.09 hrs, Volume= 0.992 af, Depth= 7.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.17"

Area (ac)	CN	Description
1.501	98	Roofs, HSG B
1.501		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-1D: PR-1D



Summary for Subcatchment PR-1E: PR-1E

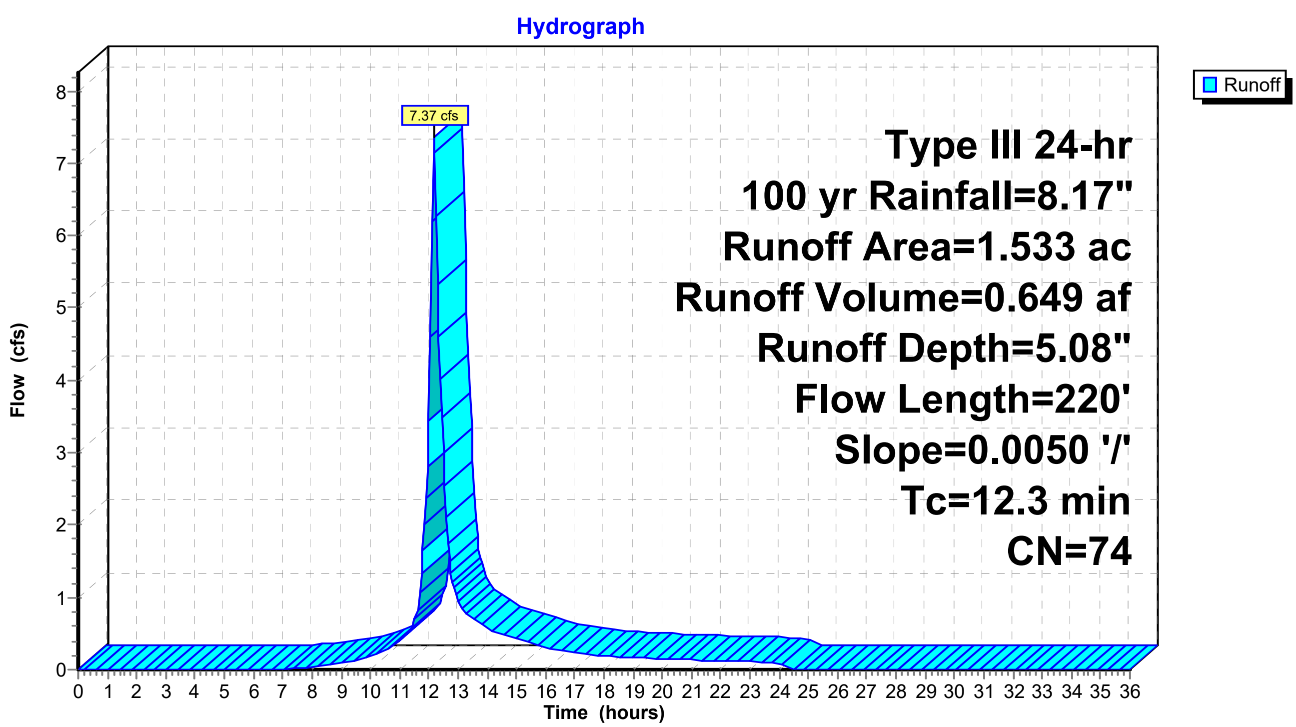
Runoff = 7.37 cfs @ 12.17 hrs, Volume= 0.649 af, Depth= 5.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.17"

Area (ac)	CN	Description
1.000	61	>75% Grass cover, Good, HSG B
0.533	98	Paved parking, HSG B
1.533	74	Weighted Average
1.000		65.23% Pervious Area
0.533		34.77% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.8	50	0.0050	0.09		**Sheet Flow, 50' SF**
					Grass: Short n= 0.150 P2= 3.20"
2.5	170	0.0050	1.14		**Shallow Concentrated Flow, 170' SCF**
					Unpaved Kv= 16.1 fps
12.3	220	Total			

Subcatchment PR-1E: PR-1E



Summary for Subcatchment PR-2: PR-2

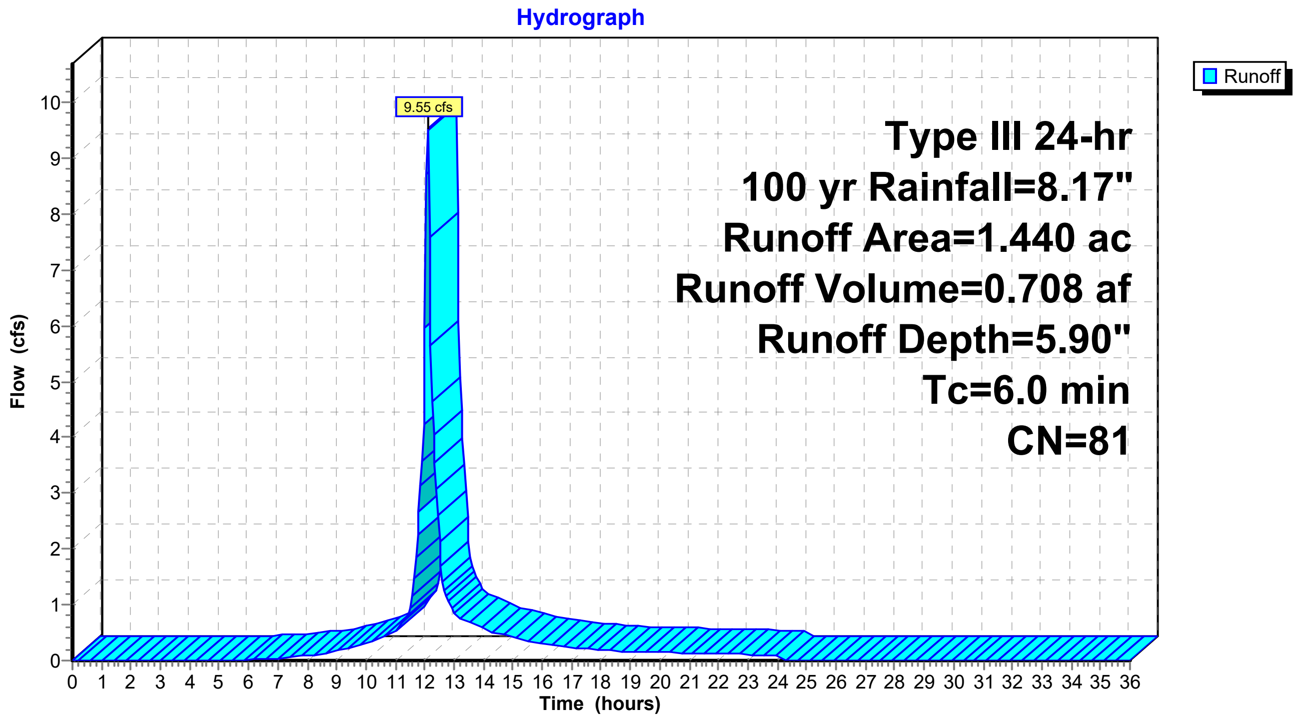
Runoff = 9.55 cfs @ 12.09 hrs, Volume= 0.708 af, Depth= 5.90"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.17"

Area (ac)	CN	Description
0.672	61	>75% Grass cover, Good, HSG B
0.768	98	Paved parking, HSG B
1.440	81	Weighted Average
0.672		46.67% Pervious Area
0.768		53.33% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-2: PR-2



Summary for Subcatchment PR-2B: PR-2B

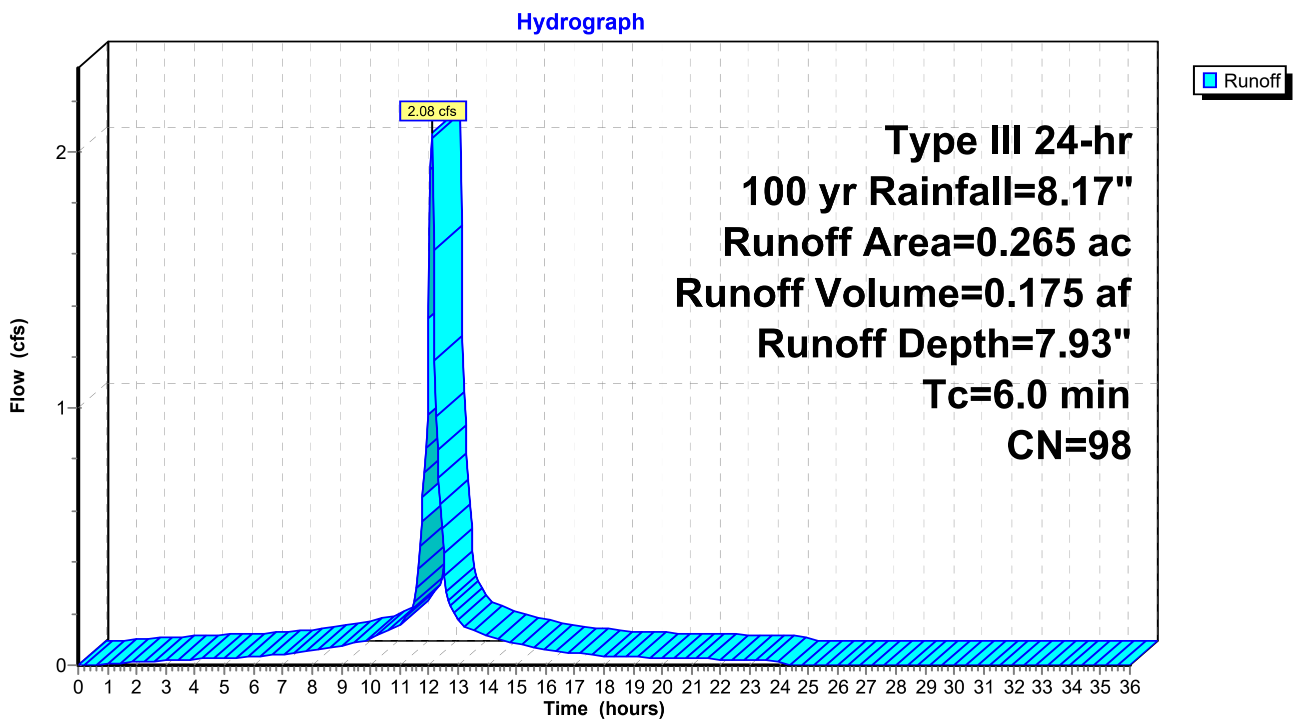
Runoff = 2.08 cfs @ 12.09 hrs, Volume= 0.175 af, Depth= 7.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.17"

Area (ac)	CN	Description
0.265	98	Roofs, HSG B
0.265		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-2B: PR-2B



Summary for Subcatchment PR-3A: PR-3A

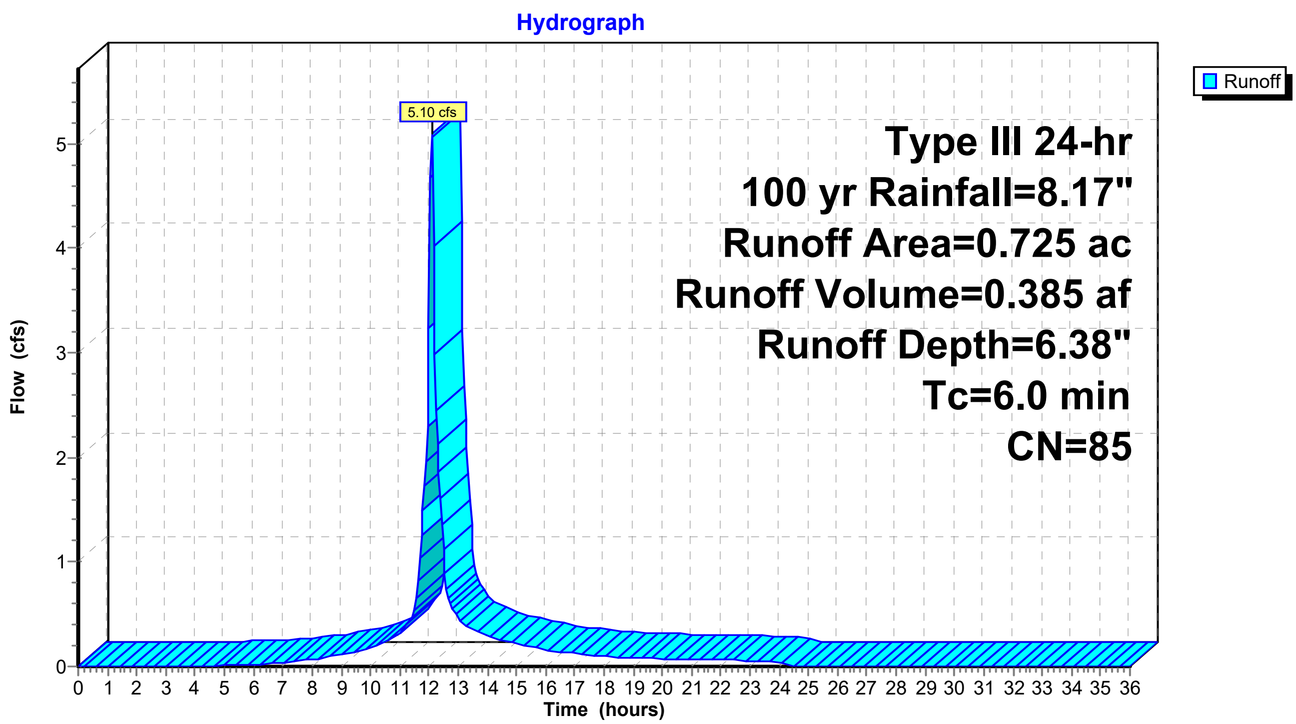
Runoff = 5.10 cfs @ 12.09 hrs, Volume= 0.385 af, Depth= 6.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.17"

Area (ac)	CN	Description
0.249	61	>75% Grass cover, Good, HSG B
0.476	98	Paved parking, HSG B
0.725	85	Weighted Average
0.249		34.34% Pervious Area
0.476		65.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-3A: PR-3A



Summary for Subcatchment PR-3B: PR-3B

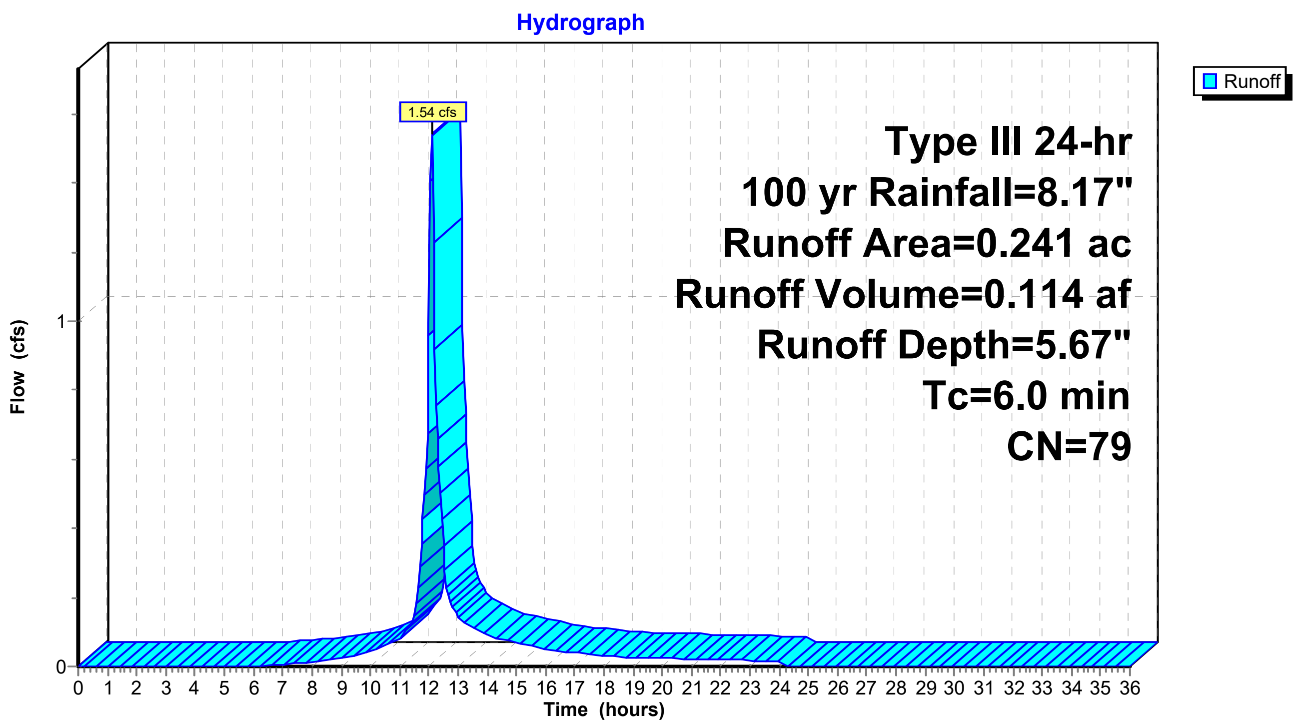
Runoff = 1.54 cfs @ 12.09 hrs, Volume= 0.114 af, Depth= 5.67"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.17"

Area (ac)	CN	Description
0.124	61	>75% Grass cover, Good, HSG B
0.117	98	Paved parking, HSG B
0.241	79	Weighted Average
0.124		51.45% Pervious Area
0.117		48.55% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment PR-3B: PR-3B



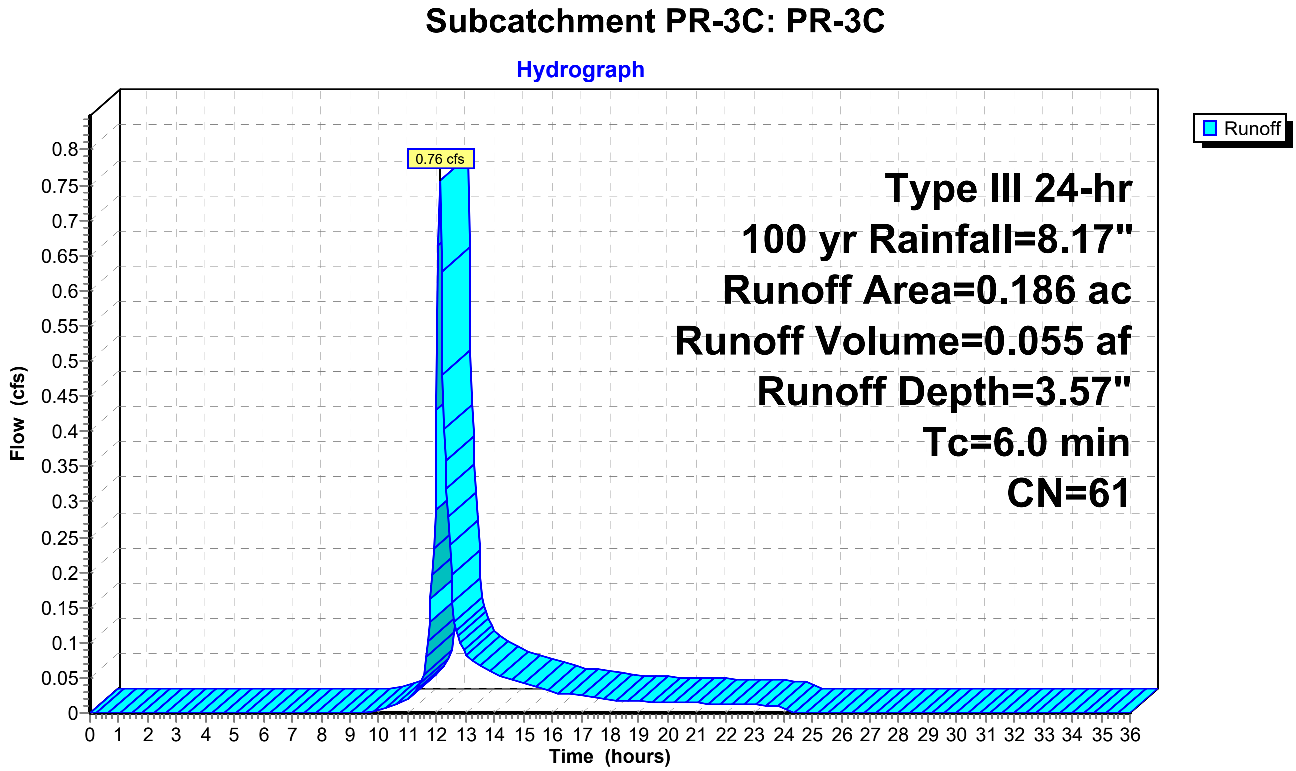
Summary for Subcatchment PR-3C: PR-3C

Runoff = 0.76 cfs @ 12.10 hrs, Volume= 0.055 af, Depth= 3.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.17"

Area (ac)	CN	Description
0.186	61	>75% Grass cover, Good, HSG B
0.186		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**



Summary for Subcatchment PR-4A: SB 01 A

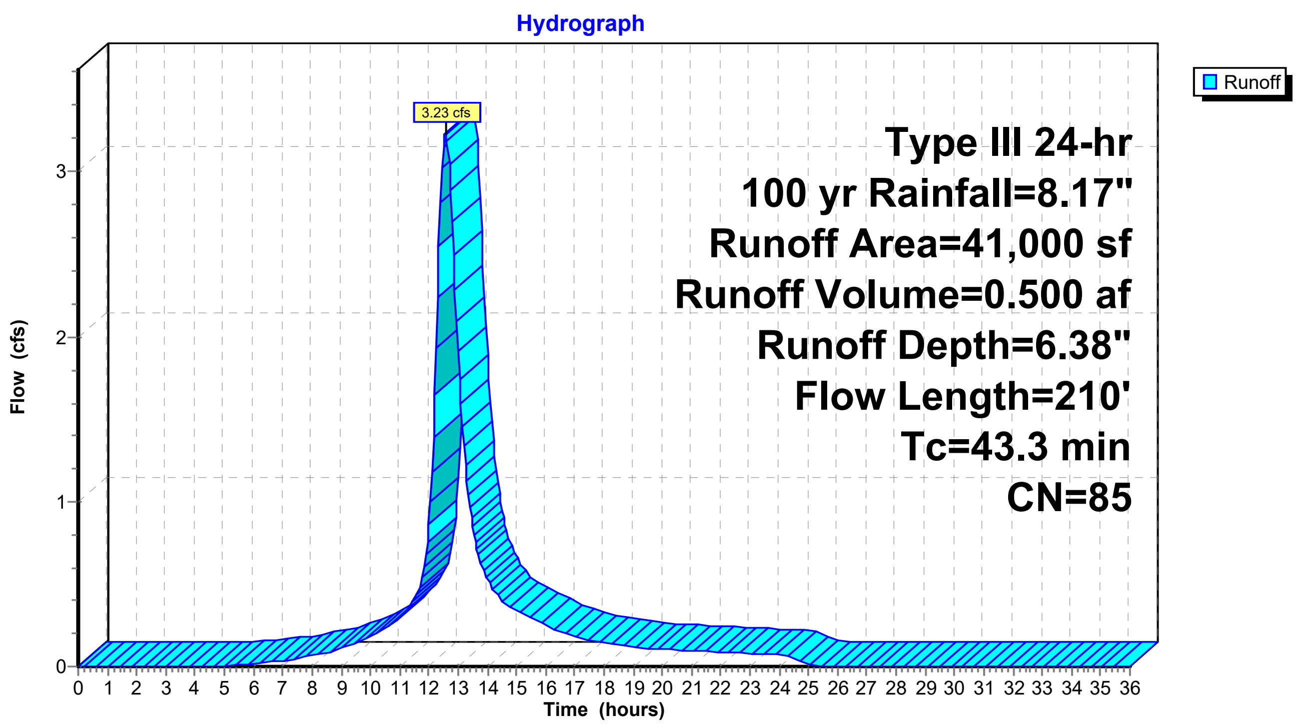
Runoff = 3.23 cfs @ 12.57 hrs, Volume= 0.500 af, Depth= 6.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.17"

	Area (sf)	CN	Description
*	41,000	85	SYNTHETIC TURF- PAD- LINER
	41,000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
39.6	110	0.0055	0.05		**Sheet Flow, Through Turf Section** Grass: Bermuda n= 0.410 P2= 3.20"
3.7	100	0.0001	0.45	0.16	**Pipe Channel, TRENCH DRAIN LEVEL** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010
43.3	210	Total			

Subcatchment PR-4A: SB 01 A



Summary for Subcatchment PR-4B: SB 11 A

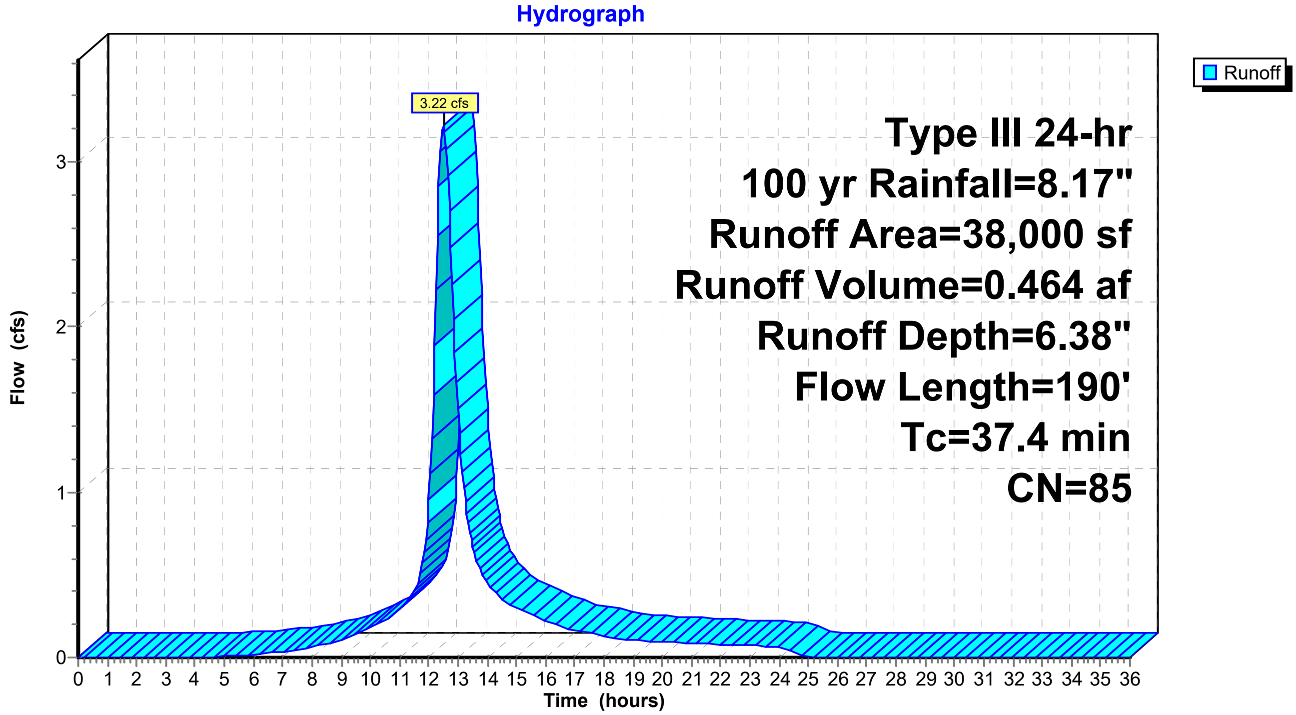
Runoff = 3.22 cfs @ 12.50 hrs, Volume= 0.464 af, Depth= 6.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.17"

	Area (sf)	CN	Description
*	38,000	85	SYNTHETIC TURF- PAD- LINER
	38,000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
33.7	90	0.0055	0.04		**Sheet Flow, Through Turf Section** Grass: Bermuda n= 0.410 P2= 3.20"
3.7	100	0.0001	0.45	0.16	**Pipe Channel, TRENCH DRAIN LEVEL** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010
37.4	190	Total			

Subcatchment PR-4B: SB 11 A



Summary for Subcatchment PR-4C: SB 00 DPW SLOPE

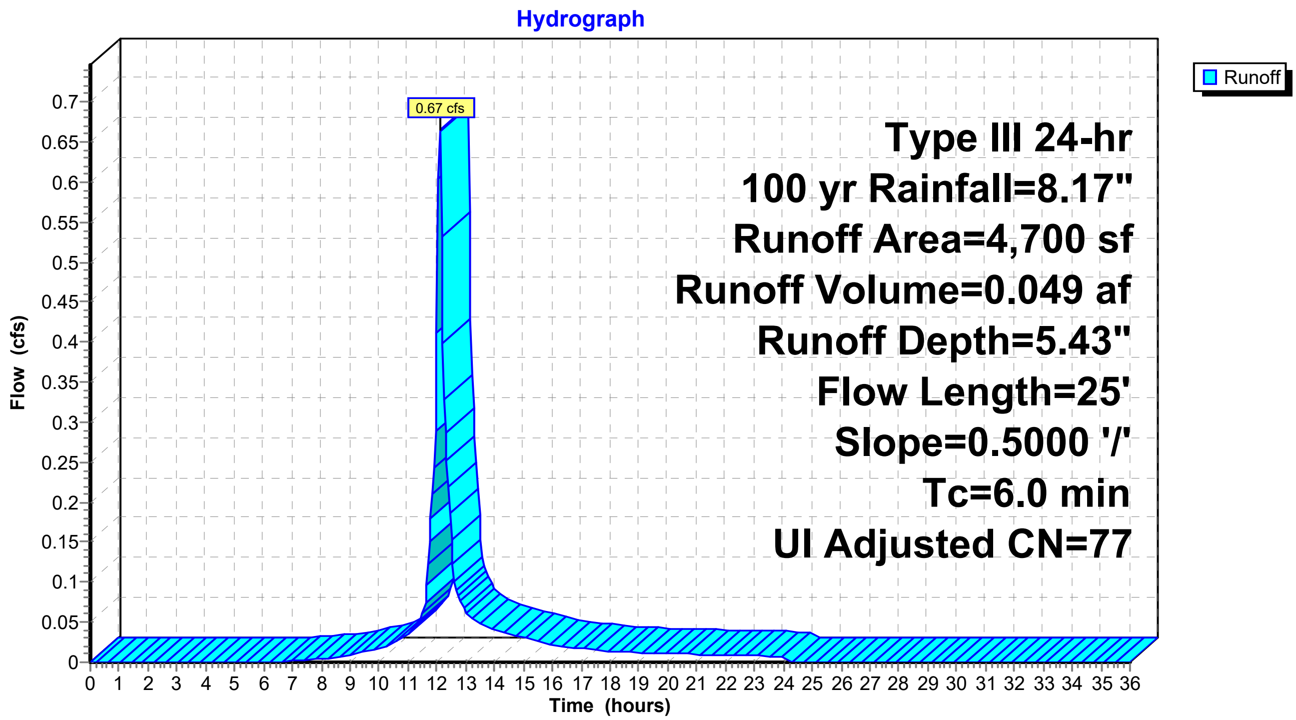
Runoff = 0.67 cfs @ 12.09 hrs, Volume= 0.049 af, Depth= 5.43"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.17"

Area (sf)	CN	Adj	Description
1,100	98		Unconnected pavement, HSG A
3,600	74		>75% Grass cover, Good, HSG C
4,700	80	77	Weighted Average, UI Adjusted
3,600			76.60% Pervious Area
1,100			23.40% Impervious Area
1,100			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.3	25	0.5000	0.32		**Sheet Flow, SLOPING LAND** Grass: Dense n= 0.240 P2= 3.20"
1.3	25	Total,	Increased to minimum Tc = 6.0 min		

Subcatchment PR-4C: SB 00 DPW SLOPE



Summary for Subcatchment PR-5A: BB 01 A

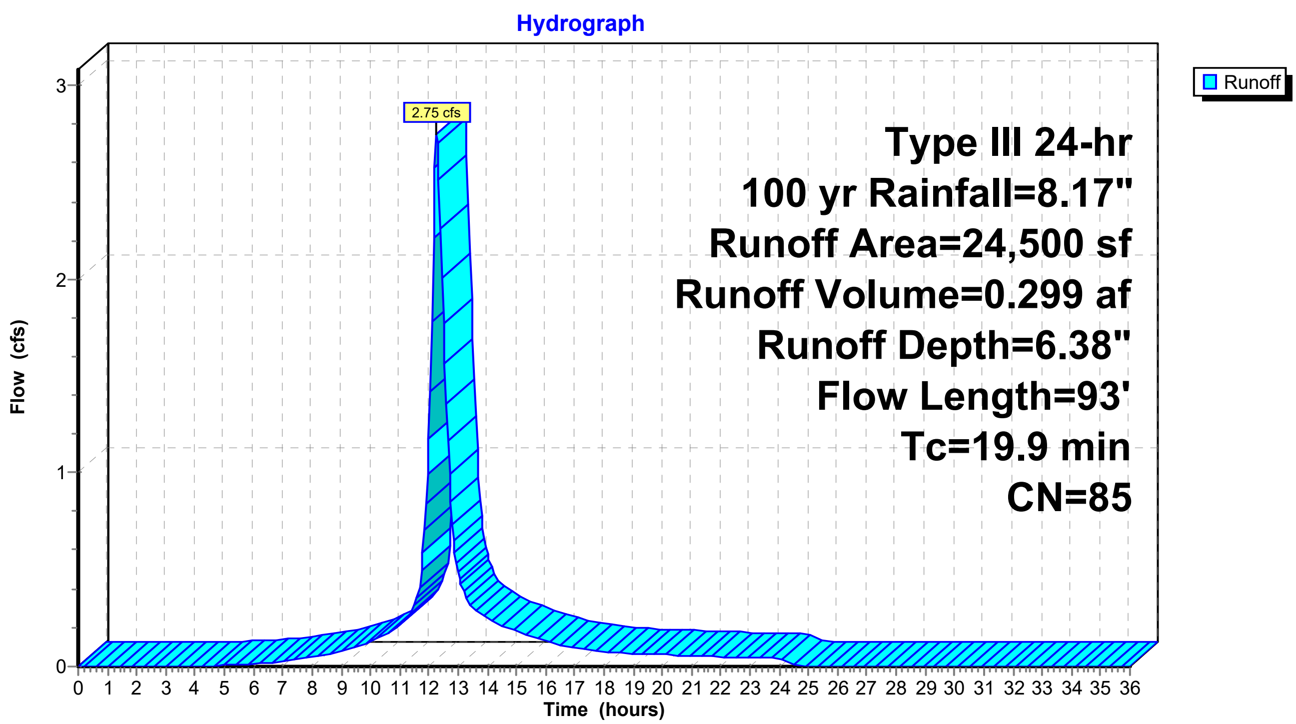
Runoff = 2.75 cfs @ 12.27 hrs, Volume= 0.299 af, Depth= 6.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.17"

	Area (sf)	CN	Description
*	24,500	85	SYNTHETIC TURF- PAD- LINER
	24,500		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.2	46	0.0067	0.04		**Sheet Flow, Through Turf Section** Grass: Bermuda n= 0.410 P2= 3.20"
1.7	47	0.0001	0.45	0.16	**Pipe Channel, TRENCH DRAIN LEVEL** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010
19.9	93	Total			

Subcatchment PR-5A: BB 01 A



Summary for Subcatchment PR-5B: BB 11 A

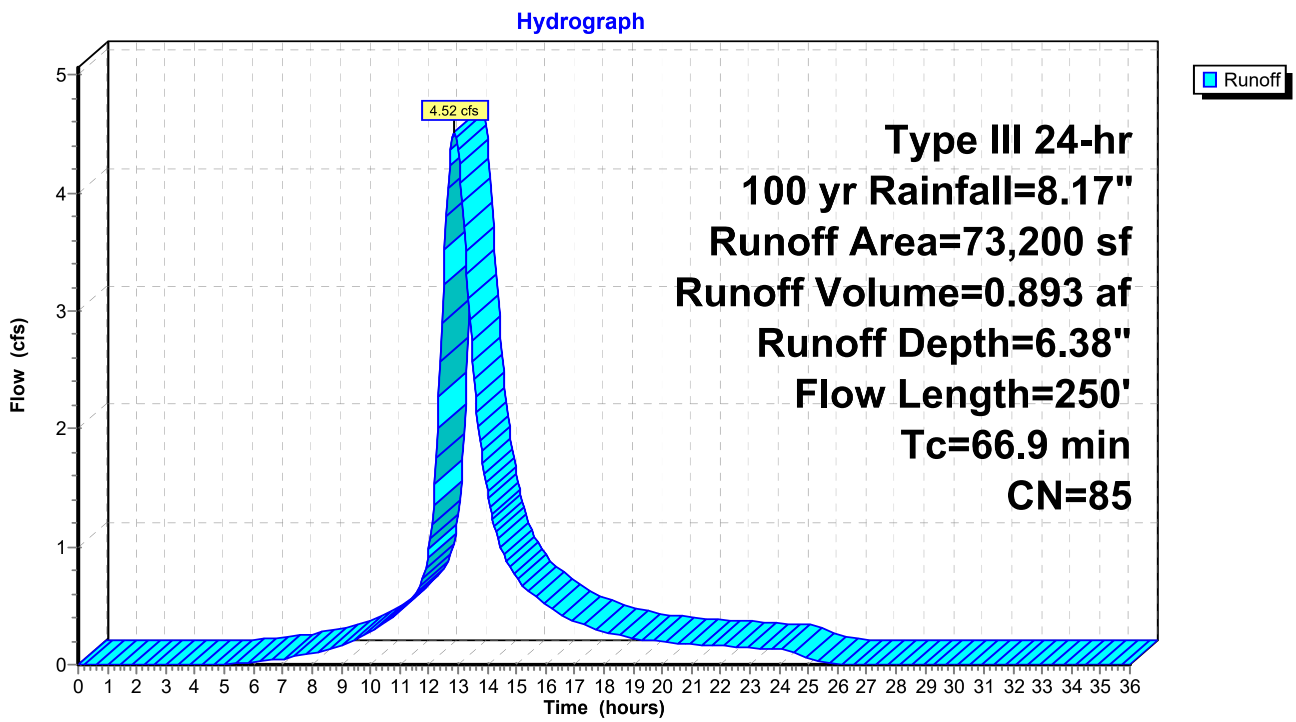
Runoff = 4.52 cfs @ 12.86 hrs, Volume= 0.893 af, Depth= 6.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.17"

	Area (sf)	CN	Description
*	73,200	85	SYNTHETIC TURF- PAD- LINER
	73,200		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.1	53	0.0055	0.04		**Sheet Flow, Through Turf Section** Grass: Bermuda n= 0.410 P2= 3.20"
43.1	150	0.0083	0.06		**Sheet Flow, SYNTHETIC TURF** Grass: Bermuda n= 0.410 P2= 3.20"
1.7	47	0.0001	0.45	0.16	**Pipe Channel, TRENCH DRAIN LEVEL** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.010
66.9	250	Total			

Subcatchment PR-5B: BB 11 A



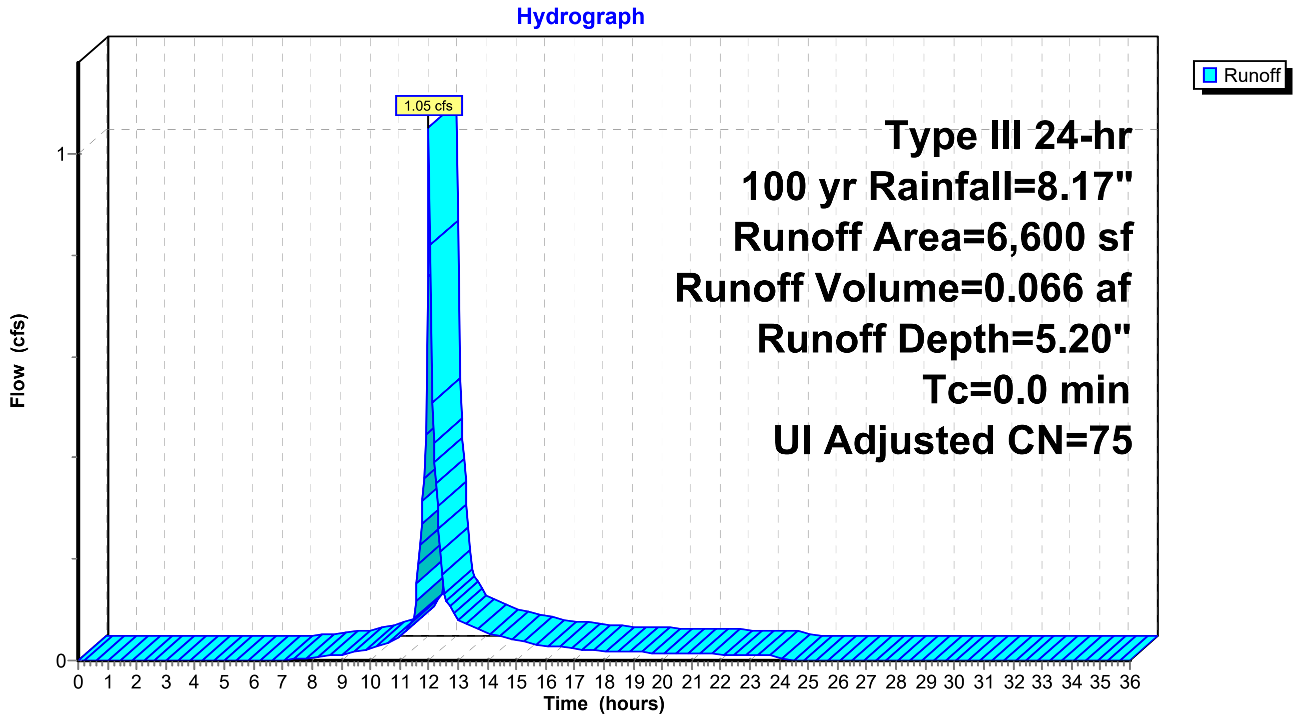
Summary for Subcatchment PR-5C: SLOPE

Runoff = 1.05 cfs @ 12.00 hrs, Volume= 0.066 af, Depth= 5.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.17"

Area (sf)	CN	Adj	Description
600	98		Unconnected roofs, HSG C
6,000	74		>75% Grass cover, Good, HSG C
6,600	76	75	Weighted Average, UI Adjusted
6,000			90.91% Pervious Area
600			9.09% Impervious Area
600			100.00% Unconnected

Subcatchment PR-5C: SLOPE



Summary for Pond 2P: rain garden#2 cascading

Inflow Area = 0.966 ac, 61.39% Impervious, Inflow Depth > 6.15" for 100 yr event
Inflow = 6.66 cfs @ 12.09 hrs, Volume= 0.495 af
Outflow = 6.67 cfs @ 12.10 hrs, Volume= 0.478 af, Atten= 0%, Lag= 0.5 min
Primary = 0.03 cfs @ 12.10 hrs, Volume= 0.051 af
Secondary = 6.64 cfs @ 12.10 hrs, Volume= 0.427 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 54.73' @ 12.10 hrs Surf.Area= 1,153 sf Storage= 1,445 cf
Flood Elev= 55.00' Surf.Area= 1,326 sf Storage= 1,784 cf

Plug-Flow detention time= 63.7 min calculated for 0.478 af (97% of inflow)
Center-of-Mass det. time= 36.9 min (855.7 - 818.8)

Volume	Invert	Avail.Storage	Storage Description
#1	51.00'	1,557 cf	**Rain Garden Envelope (Prismatic)**Listed below (Recalc) 2,357 cf Overall - 800 cf Embedded = 1,557 cf
#2	51.00'	80 cf	**crush stone (Prismatic)**Listed below (Recalc) Inside #1 200 cf Overall x 40.0% Voids
#3	51.50'	133 cf	**Bio Media (Prismatic)**Listed below (Recalc) Inside #1 532 cf Overall x 25.0% Voids
#4	52.83'	14 cf	**Mulch (Prismatic)**Listed below (Recalc) Inside #1 68 cf Overall x 20.0% Voids
		1,784 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
51.00	400	0	0
53.00	400	800	800
54.00	694	547	1,347
55.00	1,326	1,010	2,357

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
51.00	400	0	0
51.50	400	200	200

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
51.50	400	0	0
52.83	400	532	532

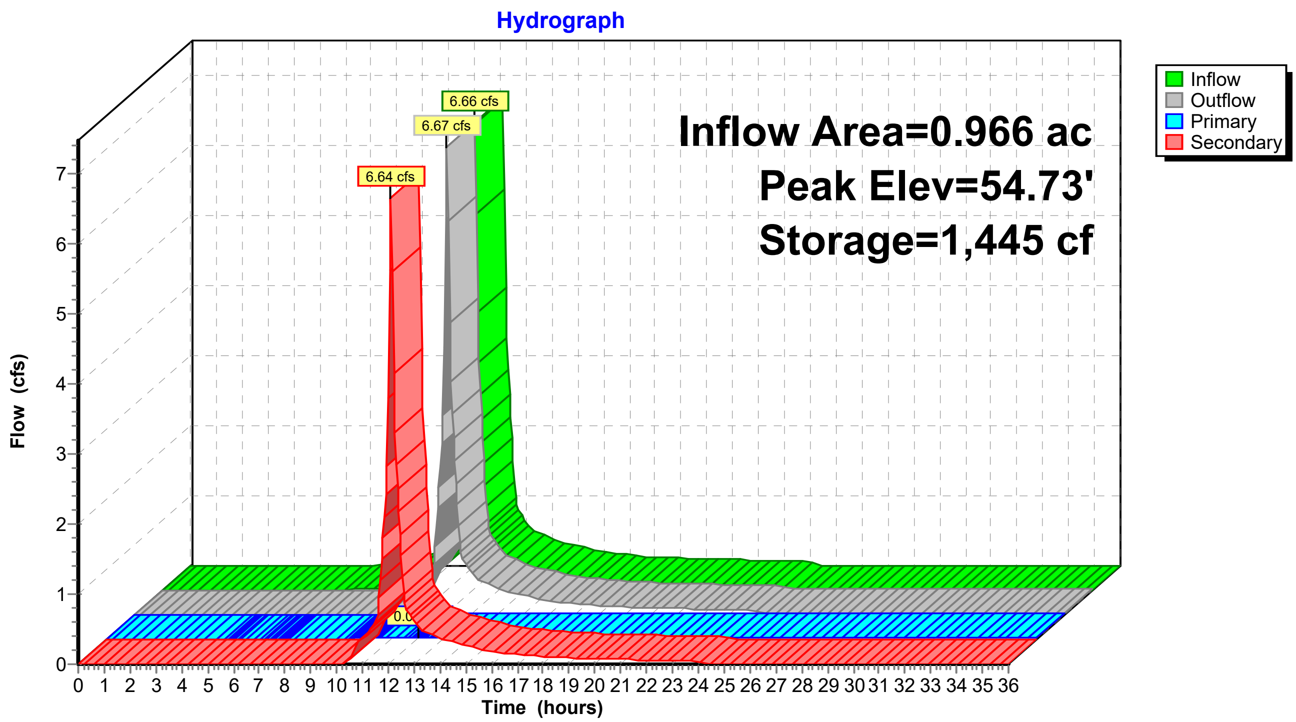
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
52.83	400	0	0
53.00	400	68	68

Device	Routing	Invert	Outlet Devices
#1	Device 3	51.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Secondary	54.50'	**25.0' long x 3.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32
#3	Primary	51.00'	**12.0" Round Culvert** L= 25.0' Ke= 0.500 Inlet / Outlet Invert= 51.00' / 50.88' S= 0.0048 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf

Primary OutFlow Max=0.03 cfs @ 12.10 hrs HW=54.73' TW=50.32' (Dynamic Tailwater)
3=Culvert (Passes 0.03 cfs of 6.79 cfs potential flow)
1=Exfiltration (Exfiltration Controls 0.03 cfs)

Secondary OutFlow Max=6.64 cfs @ 12.10 hrs HW=54.73' TW=50.32' (Dynamic Tailwater)
2=Broad-Crested Rectangular Weir (Weir Controls 6.64 cfs @ 1.17 fps)

Pond 2P: rain garden#2 cascading



Summary for Pond 3P: rain garden#3 cascading

Inflow Area = 1.152 ac, 51.48% Impervious, Inflow Depth > 5.56" for 100 yr event
Inflow = 7.43 cfs @ 12.10 hrs, Volume= 0.534 af
Outflow = 7.30 cfs @ 12.11 hrs, Volume= 0.492 af, Atten= 2%, Lag= 0.8 min
Primary = 7.30 cfs @ 12.11 hrs, Volume= 0.492 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 50.32' @ 12.11 hrs Surf.Area= 1,582 sf Storage= 2,763 cf
Flood Elev= 50.00' Surf.Area= 1,373 sf Storage= 2,283 cf

Plug-Flow detention time= 100.4 min calculated for 0.491 af (92% of inflow)
Center-of-Mass det. time= 42.4 min (896.7 - 854.4)

Volume	Invert	Avail.Storage	Storage Description
#1	46.00'	2,710 cf	**Rain Garden Envelope (Prismatic)** Listed below (Recalc) 3,911 cf Overall - 1,200 cf Embedded = 2,710 cf
#2	46.00'	120 cf	**crush stone (Prismatic)** Listed below (Recalc) Inside #1 300 cf Overall x 40.0% Voids
#3	46.50'	199 cf	**Bio Media (Prismatic)** Listed below (Recalc) Inside #1 798 cf Overall x 25.0% Voids
#4	47.83'	20 cf	**Mulch (Prismatic)** Listed below (Recalc) Inside #1 102 cf Overall x 20.0% Voids
		3,050 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
46.00	600	0	0
48.00	600	1,200	1,200
49.00	957	779	1,979
50.00	1,373	1,165	3,144
50.50	1,695	767	3,911

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
46.00	600	0	0
46.50	600	300	300

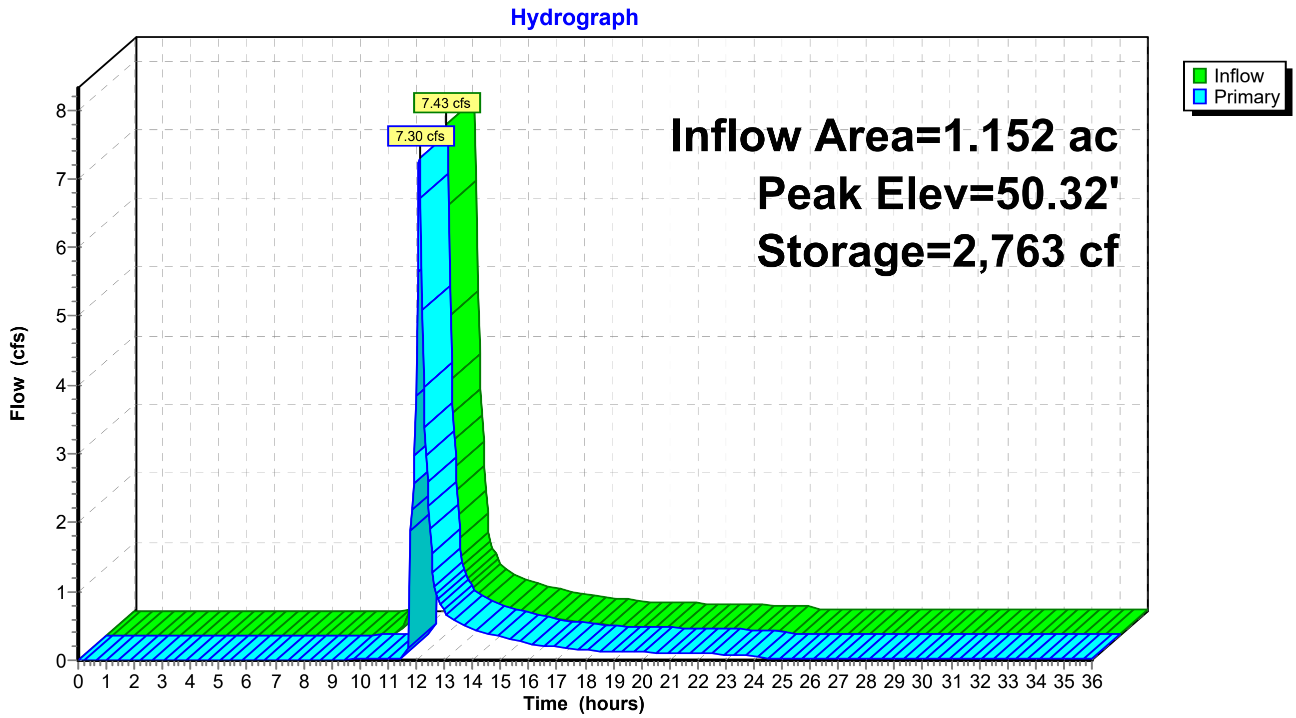
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
46.50	600	0	0
47.83	600	798	798

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
47.83	600	0	0
48.00	600	102	102

Device	Routing	Invert	Outlet Devices
#1	Device 3	46.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Device 3	50.00'	**24.0" x 48.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Primary	46.00'	**15.0" Round Culvert** L= 26.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 46.00' / 45.87' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf

Primary OutFlow Max=7.10 cfs @ 12.11 hrs HW=50.32' TW=0.00' (Dynamic Tailwater)
└─**3=Culvert** (Passes 7.10 cfs of 8.97 cfs potential flow)
  ├─**1=Exfiltration** (Exfiltration Controls 0.04 cfs)
  └─**2=Orifice/Grate** (Weir Controls 7.06 cfs @ 1.85 fps)

Pond 3P: rain garden#3 cascading



Summary for Pond 4P: UGS-1

Inflow Area = 1.705 ac, 60.59% Impervious, Inflow Depth = 6.22" for 100 yr event
Inflow = 11.62 cfs @ 12.09 hrs, Volume= 0.883 af
Outflow = 11.63 cfs @ 12.10 hrs, Volume= 0.845 af, Atten= 0%, Lag= 0.5 min
Discarded = 0.04 cfs @ 6.65 hrs, Volume= 0.107 af
Primary = 11.59 cfs @ 12.10 hrs, Volume= 0.738 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 44.18' @ 12.10 hrs Surf.Area= 1,672 sf Storage= 4,815 cf

Plug-Flow detention time= 96.7 min calculated for 0.844 af (96% of inflow)
Center-of-Mass det. time= 72.8 min (860.9 - 788.1)

Volume	Invert	Avail.Storage	Storage Description
#1A	39.50'	2,099 cf	**29.92'W x 55.89'L x 5.50'H Field A** 9,196 cf Overall - 3,198 cf Embedded = 5,998 cf x 35.0% Voids
#2A	40.25'	3,198 cf	**ADS_StormTech MC-3500 d +Cap** x 28 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap 28 Chambers in 4 Rows Cap Storage= +14.9 cf x 2 x 4 rows = 119.2 cf
		5,297 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	39.25'	**24.0" Round Culvert** L= 50.0' Ke= 0.500 Inlet / Outlet Invert= 39.25' / 38.75' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf
#2	Device 1	43.67'	**5.0' long x 4.00' rise Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Discarded	39.50'	**1.020 in/hr Exfiltration over Surface area**
#4	Device 1	42.42'	**9.0" Vert. Orifice/Grate** X 3 rows with 6.0" cc spacing C= 0.600

Discarded OutFlow Max=0.04 cfs @ 6.65 hrs HW=39.59' (Free Discharge)
└─**3=Exfiltration** (Exfiltration Controls 0.04 cfs)

Primary OutFlow Max=11.51 cfs @ 12.10 hrs HW=44.17' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Passes 11.51 cfs of 29.96 cfs potential flow)
  ├─**2=Sharp-Crested Rectangular Weir** (Weir Controls 5.71 cfs @ 2.32 fps)
  └─**4=Orifice/Grate** (Orifice Controls 5.80 cfs @ 4.37 fps)

Pond 4P: UGS-1 - Chamber Wizard Field A

Chamber Model = ADS_StormTechMC-3500 d +Cap (ADS StormTech®MC-3500 d rev 03/14 with Cap volume)
Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf
Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap
Cap Storage= +14.9 cf x 2 x 4 rows = 119.2 cf

77.0" Wide + 9.0" Spacing = 86.0" C-C Row Spacing

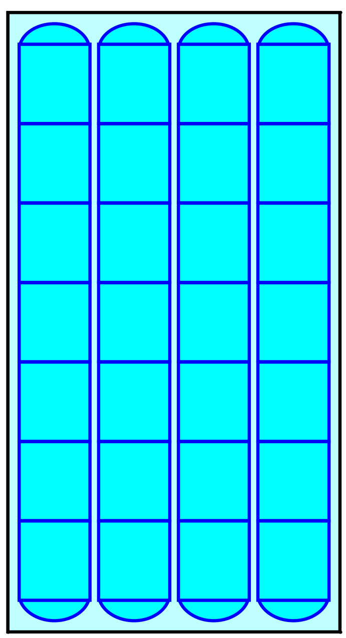
7 Chambers/Row x 7.17' Long +1.85' Cap Length x 2 = 53.89' Row Length +12.0" End Stone x 2 = 55.89' Base Length
4 Rows x 77.0" Wide + 9.0" Spacing x 3 + 12.0" Side Stone x 2 = 29.92' Base Width
9.0" Base + 45.0" Chamber Height + 12.0" Cover = 5.50' Field Height

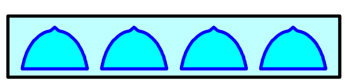
28 Chambers x 110.0 cf + 14.9 cf Cap Volume x 2 x 4 Rows = 3,197.9 cf Chamber Storage

9,196.2 cf Field - 3,197.9 cf Chambers = 5,998.4 cf Stone x 35.0% Voids = 2,099.4 cf Stone Storage

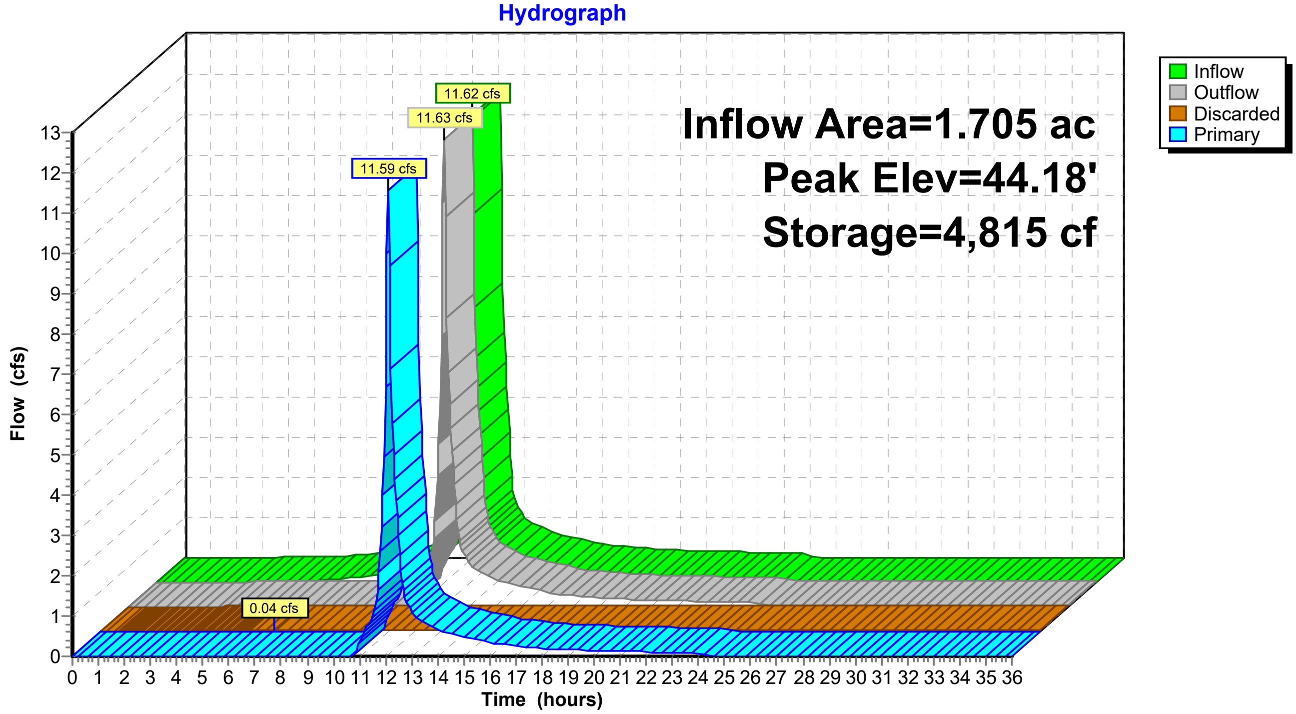
Chamber Storage + Stone Storage = 5,297.3 cf = 0.122 af
Overall Storage Efficiency = 57.6%
Overall System Size = 55.89' x 29.92' x 5.50'

28 Chambers
340.6 cy Field
222.2 cy Stone





Pond 4P: UGS-1


Hydrograph
Inflow
Outflow
Discarded
Primary
11.62 cfs
11.63 cfs
11.59 cfs
0.04 cfs
Inflow Area=1.705 ac
Peak Elev=44.18'
Storage=4,815 cf
Flow (cfs)
Time (hours)
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Summary for Pond 5P: rain garden#1 cascading

Inflow Area = 0.725 ac, 65.66% Impervious, Inflow Depth = 6.38" for 100 yr event
Inflow = 5.10 cfs @ 12.09 hrs, Volume= 0.385 af
Outflow = 5.12 cfs @ 12.09 hrs, Volume= 0.381 af, Atten= 0%, Lag= 0.3 min
Primary = 0.01 cfs @ 12.09 hrs, Volume= 0.026 af
Secondary = 5.10 cfs @ 12.09 hrs, Volume= 0.356 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 62.19' @ 12.09 hrs Surf.Area= 533 sf Storage= 650 cf
Flood Elev= 63.00' Surf.Area= 660 sf Storage= 1,132 cf

Plug-Flow detention time= 39.2 min calculated for 0.381 af (99% of inflow)
Center-of-Mass det. time= 33.4 min (823.1 - 789.8)

Volume	Invert	Avail.Storage	Storage Description
#1	58.50'	1,048 cf	**Rain Garden Envelope (Prismatic)** Listed below (Recalc) 1,348 cf Overall - 300 cf Embedded = 1,048 cf
#2	58.50'	30 cf	**crush stone (Prismatic)** Listed below (Recalc) Inside #1 75 cf Overall x 40.0% Voids
#3	59.00'	50 cf	**Bio Media (Prismatic)** Listed below (Recalc) Inside #1 199 cf Overall x 25.0% Voids
#4	60.33'	5 cf	**Mulch (Prismatic)** Listed below (Recalc) Inside #1 26 cf Overall x 20.0% Voids
		1,132 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
58.50	150	0	0
60.50	150	300	300
61.00	236	97	397
62.00	503	370	766
63.00	660	582	1,348

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
58.50	150	0	0
59.00	150	75	75

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
59.00	150	0	0
60.33	150	199	199

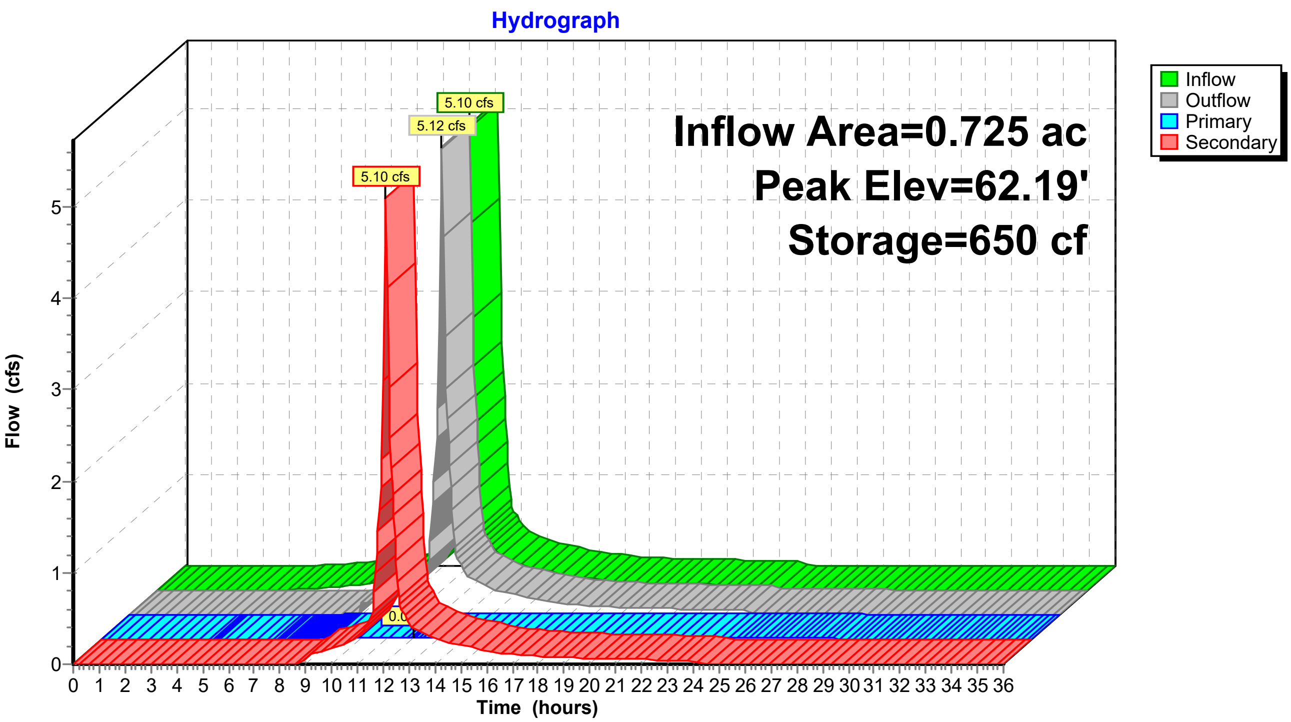
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
60.33	150	0	0
60.50	150	26	26

Device	Routing	Invert	Outlet Devices
#1	Device 3	58.50'	**1.020 in/hr Exfiltration over Surface area**
#2	Secondary	62.00'	**25.0' long x 3.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32
#3	Primary	58.50'	**8.0" Round Culvert** L= 20.0' Ke= 0.500 Inlet / Outlet Invert= 58.50' / 58.40' S= 0.0050 '/' Cc= 0.900 n= 0.012, Flow Area= 0.35 sf

Primary OutFlow Max=0.01 cfs @ 12.09 hrs HW=62.19' TW=54.72' (Dynamic Tailwater)
└─**3=Culvert** (Passes 0.01 cfs of 3.08 cfs potential flow)
  └─**1=Exfiltration** (Exfiltration Controls 0.01 cfs)

Secondary OutFlow Max=5.01 cfs @ 12.09 hrs HW=62.19' TW=54.72' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir** (Weir Controls 5.01 cfs @ 1.06 fps)

Pond 5P: rain garden#1 cascading



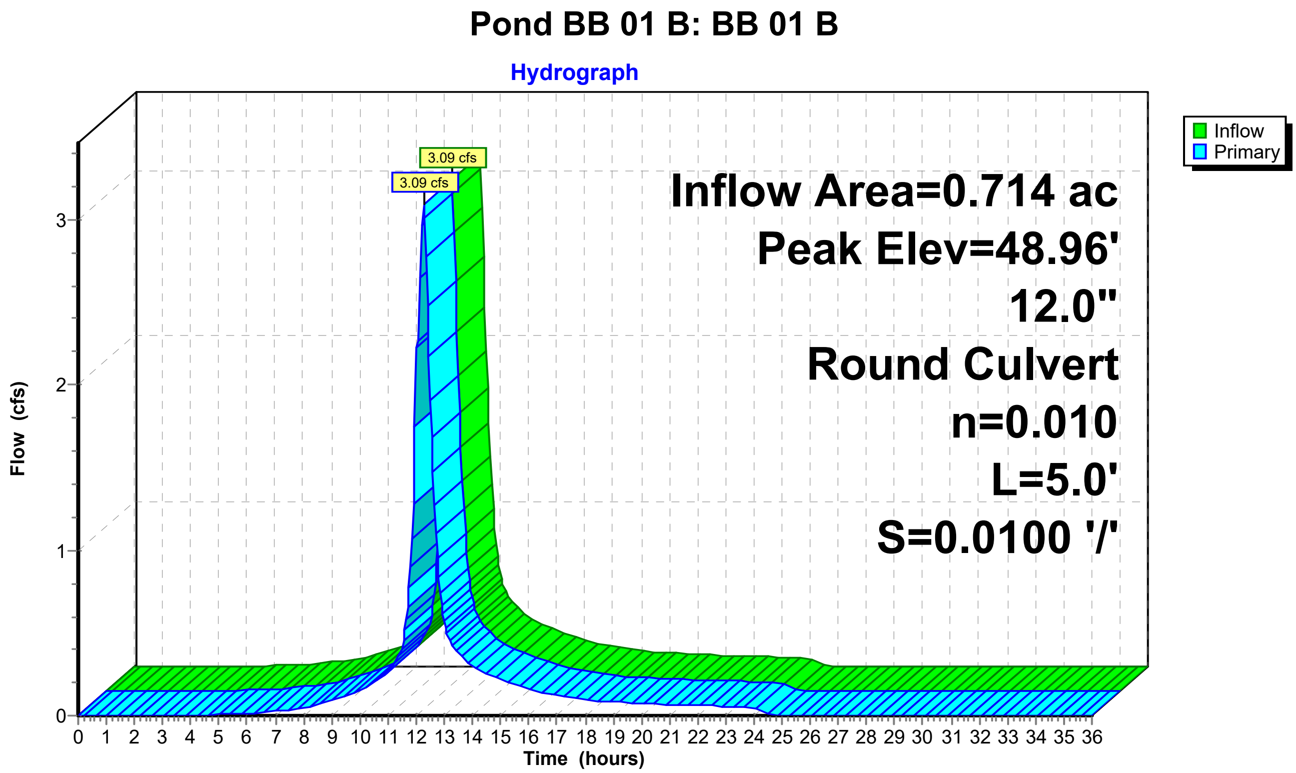
Summary for Pond BB 01 B: BB 01 B

Inflow Area =	0.714 ac,	1.93% Impervious, Inflow Depth = 6.13"	for 100 yr event	
Inflow =	3.09 cfs @	12.25 hrs, Volume=	0.365 af	
Outflow =	3.09 cfs @	12.25 hrs, Volume=	0.365 af,	Atten= 0%, Lag= 0.0 min
Primary =	3.09 cfs @	12.25 hrs, Volume=	0.365 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 48.96' @ 12.25 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	47.63'	**12.0" Round Culvert** L= 5.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 47.63' / 47.58' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=3.08 cfs @ 12.25 hrs HW=48.95' TW=47.09' (Dynamic Tailwater)
└**1=Culvert** (Barrel Controls 3.08 cfs @ 3.93 fps)



Summary for Pond BB 01 S: BB 01 S

Inflow Area = 0.714 ac, 1.93% Impervious, Inflow Depth = 6.13" for 100 yr event
Inflow = 3.09 cfs @ 12.25 hrs, Volume= 0.365 af
Outflow = 0.78 cfs @ 12.83 hrs, Volume= 0.365 af, Atten= 75%, Lag= 34.5 min
Primary = 0.78 cfs @ 12.83 hrs, Volume= 0.365 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 47.45' @ 12.83 hrs Surf.Area= 0 sf Storage= 6,588 cf

Plug-Flow detention time= 175.1 min calculated for 0.364 af (100% of inflow)
Center-of-Mass det. time= 175.0 min (978.6 - 803.6)

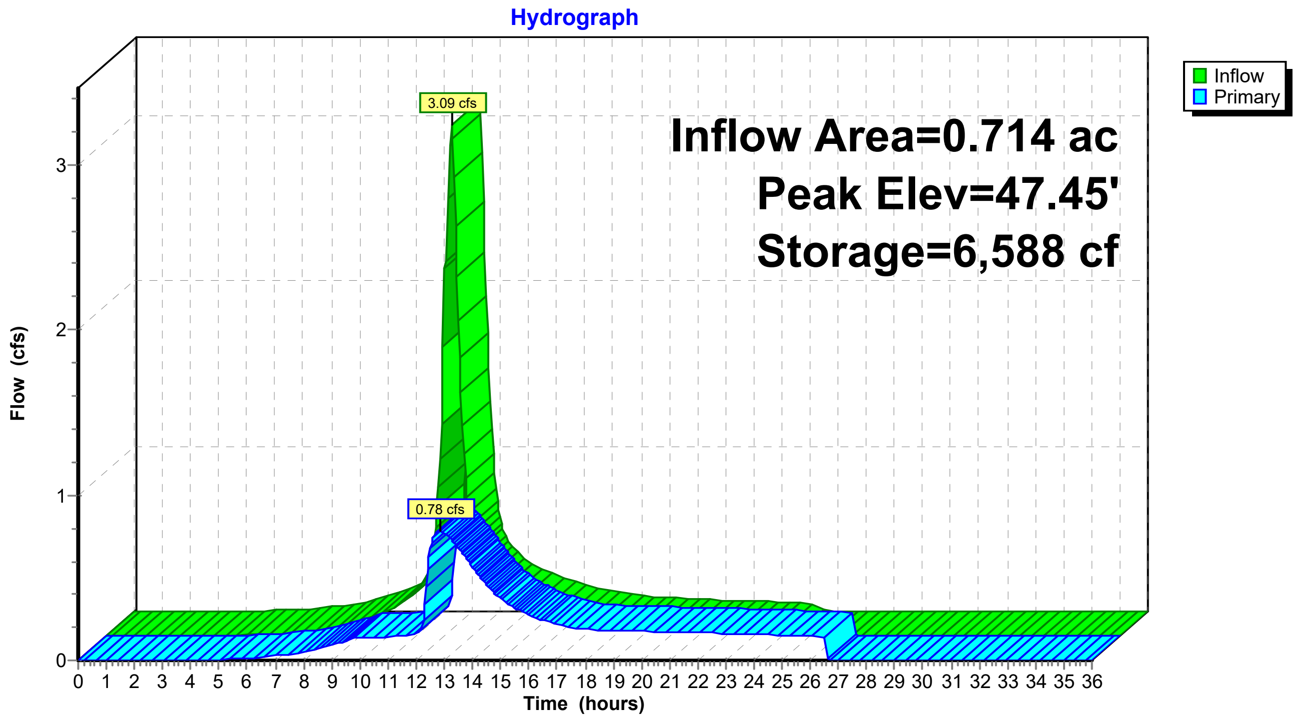
Volume	Invert	Avail.Storage	Storage Description
#1	45.65'	8,017 cf	**Custom Stage Data** Listed below

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
45.65	0	0
46.48	16	16
46.98	3,378	3,394
47.48	3,405	6,799
47.98	1,218	8,017

Device	Routing	Invert	Outlet Devices
#1	Primary	45.65'	**2.5" Vert. Orifice/Grate** C= 0.600
#2	Primary	46.98'	**4.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	46.98'	**5.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.78 cfs @ 12.83 hrs HW=47.45' TW=45.72' (Dynamic Tailwater)
├─**1=Orifice/Grate** (Orifice Controls 0.21 cfs @ 6.27 fps)
├─**2=Orifice/Grate** (Orifice Controls 0.23 cfs @ 2.65 fps)
└─**3=Orifice/Grate** (Orifice Controls 0.34 cfs @ 2.46 fps)

Pond BB 01 S: BB 01 S



Summary for Pond BB 06 B: BB 06 B

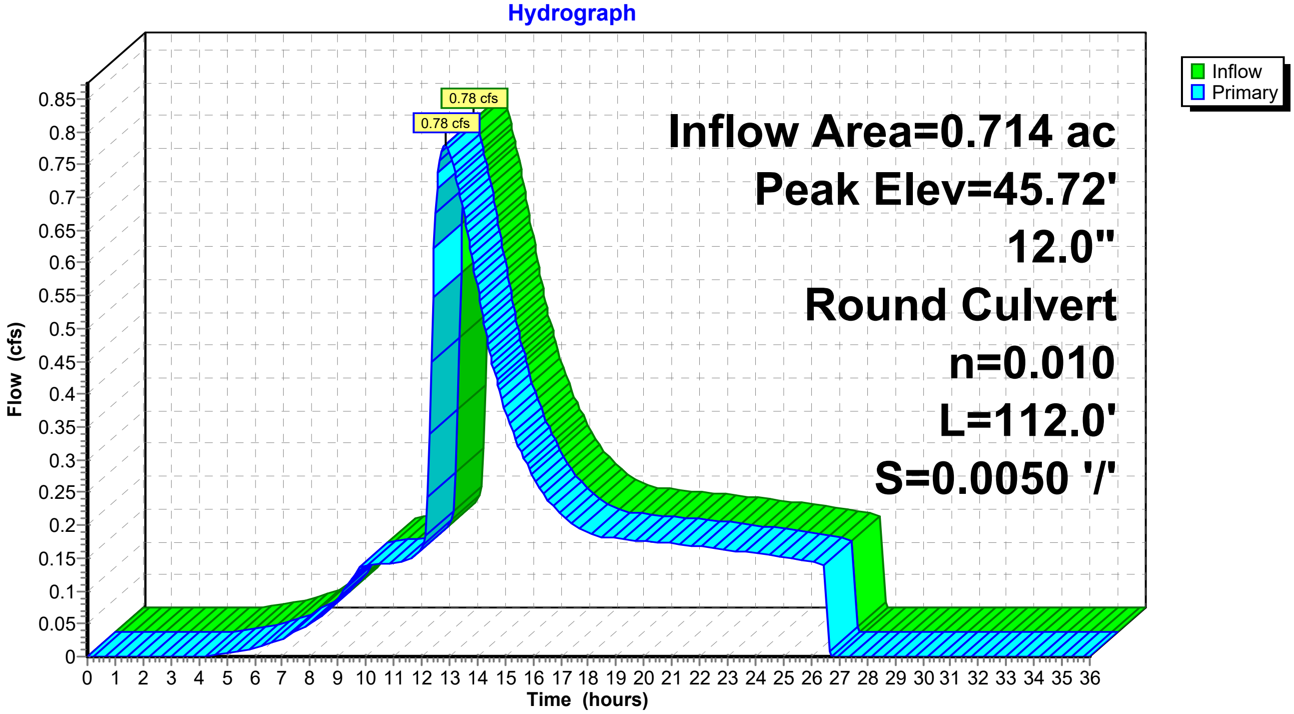
Inflow Area =	0.714 ac,	1.93% Impervious,	Inflow Depth = 6.13"	for 100 yr event
Inflow =	0.78 cfs @	12.83 hrs, Volume=	0.365 af	
Outflow =	0.78 cfs @	12.83 hrs, Volume=	0.365 af, Atten= 0%, Lag= 0.0 min	
Primary =	0.78 cfs @	12.83 hrs, Volume=	0.365 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 45.72' @ 12.83 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	45.25'	**12.0" Round Culvert** L= 112.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 45.25' / 44.69' S= 0.0050 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=0.78 cfs @ 12.83 hrs HW=45.72' TW=44.98' (Dynamic Tailwater)
└**1=Culvert** (Barrel Controls 0.78 cfs @ 3.15 fps)

Pond BB 06 B: BB 06 B



Summary for Pond BB 07 B: BB 07 B

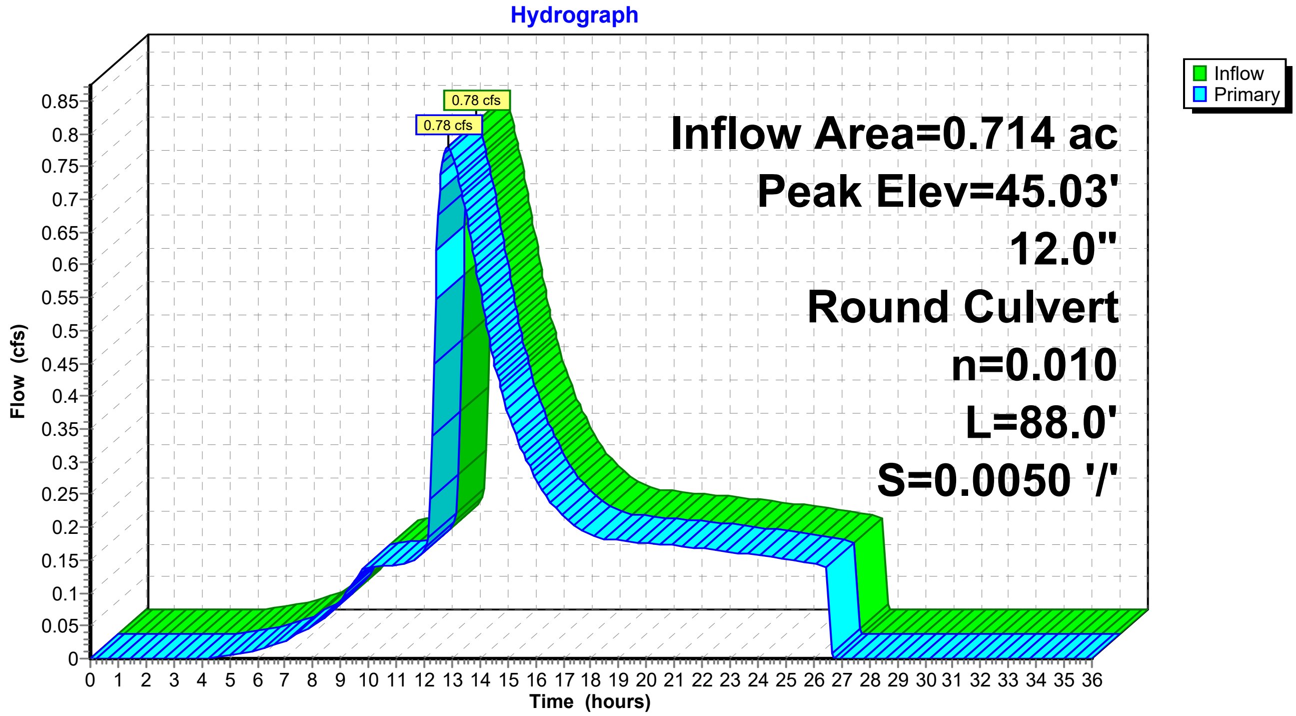
Inflow Area =	0.714 ac,	1.93% Impervious,	Inflow Depth =	6.13"	for 100 yr event
Inflow =	0.78 cfs @	12.83 hrs,	Volume=	0.365 af	
Outflow =	0.78 cfs @	12.83 hrs,	Volume=	0.365 af,	Atten= 0%, Lag= 0.0 min
Primary =	0.78 cfs @	12.83 hrs,	Volume=	0.365 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 45.03' @ 13.31 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	44.50'	**12.0" Round Culvert** L= 88.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 44.50' / 44.06' S= 0.0050 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=0.76 cfs @ 12.83 hrs HW=44.98' TW=44.46' (Dynamic Tailwater)
└**1=Culvert** (Outlet Controls 0.76 cfs @ 2.99 fps)

Pond BB 07 B: BB 07 B



Summary for Pond BB 11 B: BB 11 B

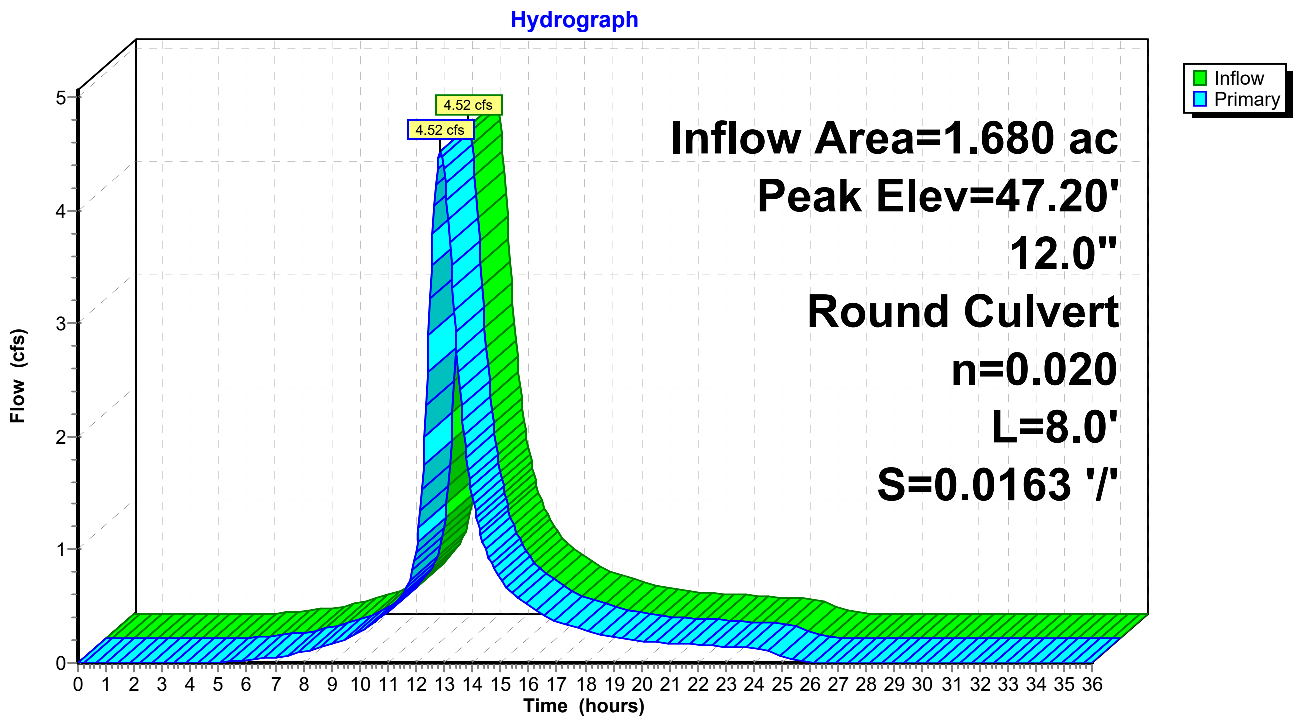
Inflow Area =	1.680 ac,	0.00% Impervious, Inflow Depth = 6.38"	for 100 yr event	
Inflow =	4.52 cfs @	12.86 hrs, Volume=	0.893 af	
Outflow =	4.52 cfs @	12.86 hrs, Volume=	0.893 af,	Atten= 0%, Lag= 0.0 min
Primary =	4.52 cfs @	12.86 hrs, Volume=	0.893 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 47.20' @ 12.86 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	45.25'	**12.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 45.25' / 45.12' S= 0.0163 '/' Cc= 0.900 n= 0.020, Flow Area= 0.79 sf

Primary OutFlow Max=4.51 cfs @ 12.86 hrs HW=47.19' TW=45.75' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 4.51 cfs @ 5.75 fps)

Pond BB 11 B: BB 11 B



Summary for Pond BB 11 S: BB 11 S

Inflow Area = 1.680 ac, 0.00% Impervious, Inflow Depth = 6.38" for 100 yr event
Inflow = 4.52 cfs @ 12.86 hrs, Volume= 0.893 af
Outflow = 3.07 cfs @ 13.36 hrs, Volume= 0.893 af, Atten= 32%, Lag= 29.8 min
Primary = 3.07 cfs @ 13.36 hrs, Volume= 0.893 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 46.37' @ 13.36 hrs Surf.Area= 0 sf Storage= 7,197 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 23.2 min (869.4 - 846.2)

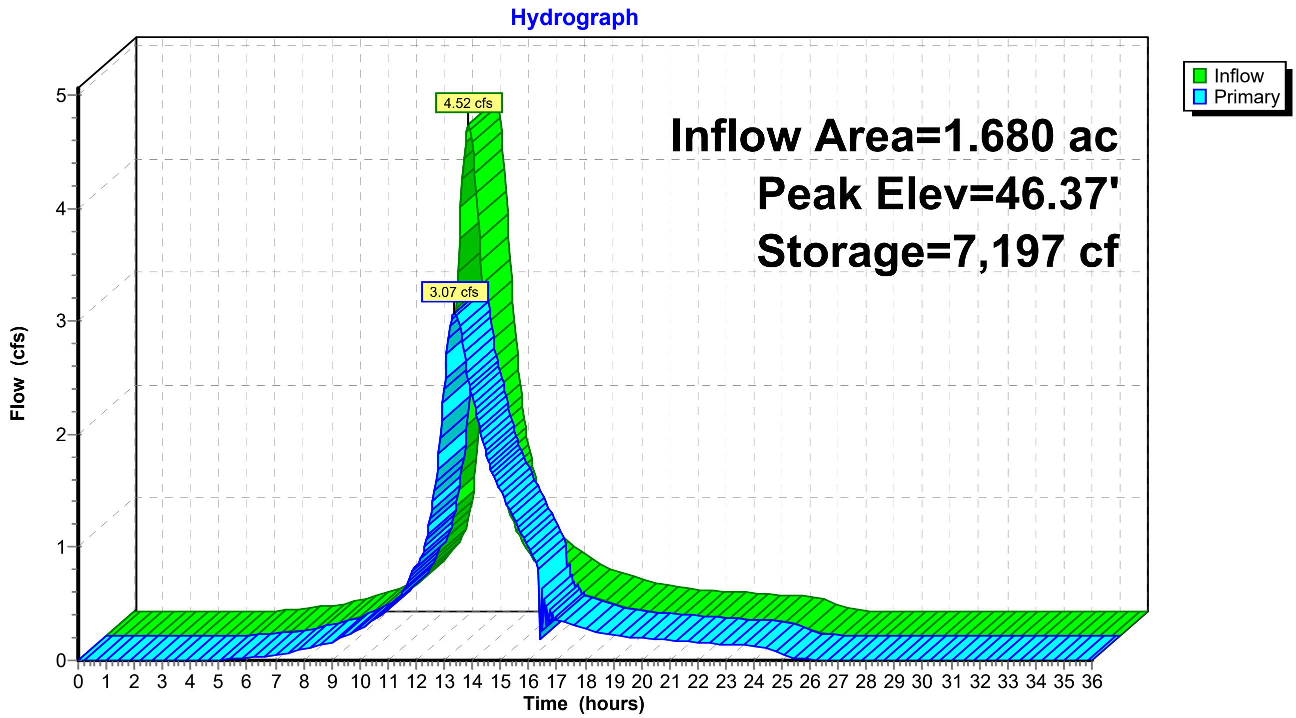
Volume	Invert	Avail.Storage	Storage Description
#1	44.14'	7,432 cf	**Custom Stage Data** Listed below

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
44.14	0	0
44.97	16	16
45.47	3,131	3,147
45.97	3,156	6,303
46.47	1,129	7,432

Device	Routing	Invert	Outlet Devices
#1	Primary	44.14'	**2.5" Vert. Orifice/Grate** C= 0.600
#2	Primary	44.47'	**8.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	45.47'	**6.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=3.07 cfs @ 13.36 hrs HW=46.36' TW=44.70' (Dynamic Tailwater)
├─**1=Orifice/Grate** (Orifice Controls 0.21 cfs @ 6.21 fps)
├─**2=Orifice/Grate** (Orifice Controls 2.10 cfs @ 6.02 fps)
└─**3=Orifice/Grate** (Orifice Controls 0.76 cfs @ 3.87 fps)

Pond BB 11 S: BB 11 S



Summary for Pond PR-4: SB 01 DMH

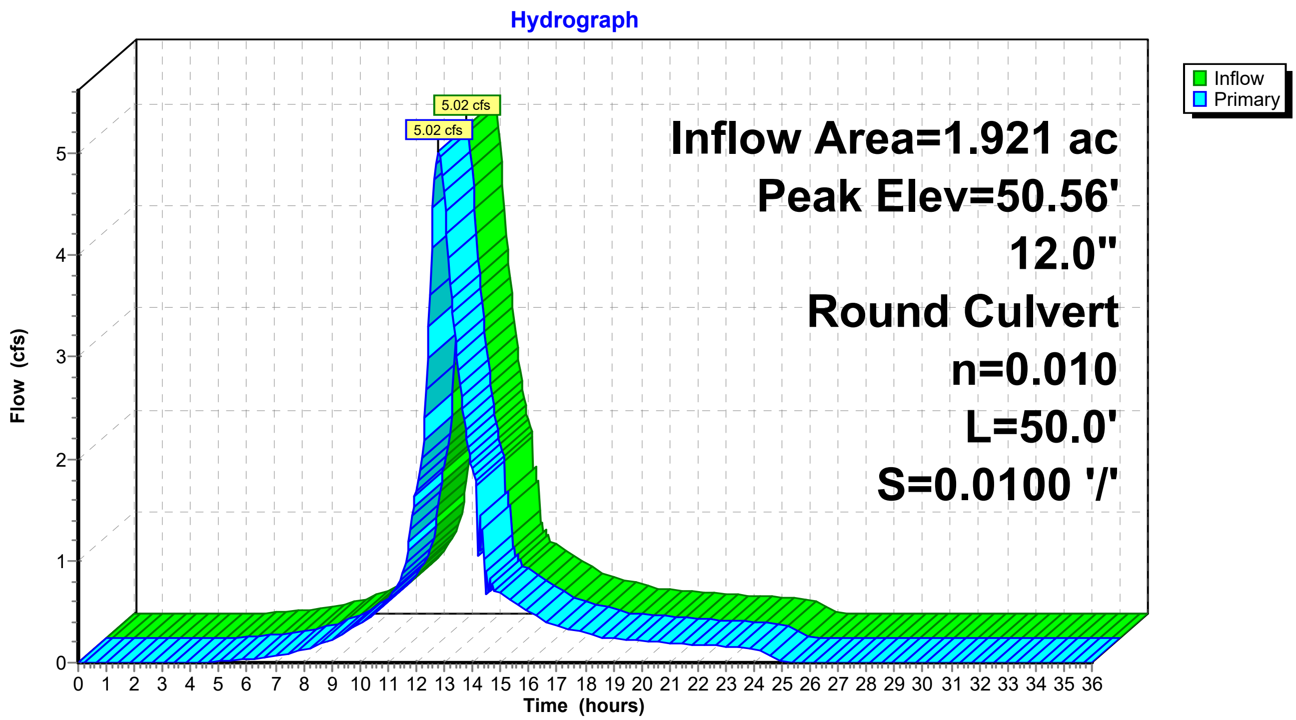
Inflow Area = 1.921 ac, 1.31% Impervious, Inflow Depth = 6.32" for 100 yr event
Inflow = 5.02 cfs @ 12.80 hrs, Volume= 1.013 af
Outflow = 5.02 cfs @ 12.80 hrs, Volume= 1.013 af, Atten= 0%, Lag= 0.0 min
Primary = 5.02 cfs @ 12.80 hrs, Volume= 1.013 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 50.56' @ 12.80 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	48.30'	**12.0" Round Culvert** L= 50.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 48.30' / 47.80' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=5.01 cfs @ 12.80 hrs HW=50.56' TW=0.00' (Dynamic Tailwater)
1=Culvert (Inlet Controls 5.01 cfs @ 6.38 fps)

Pond PR-4: SB 01 DMH



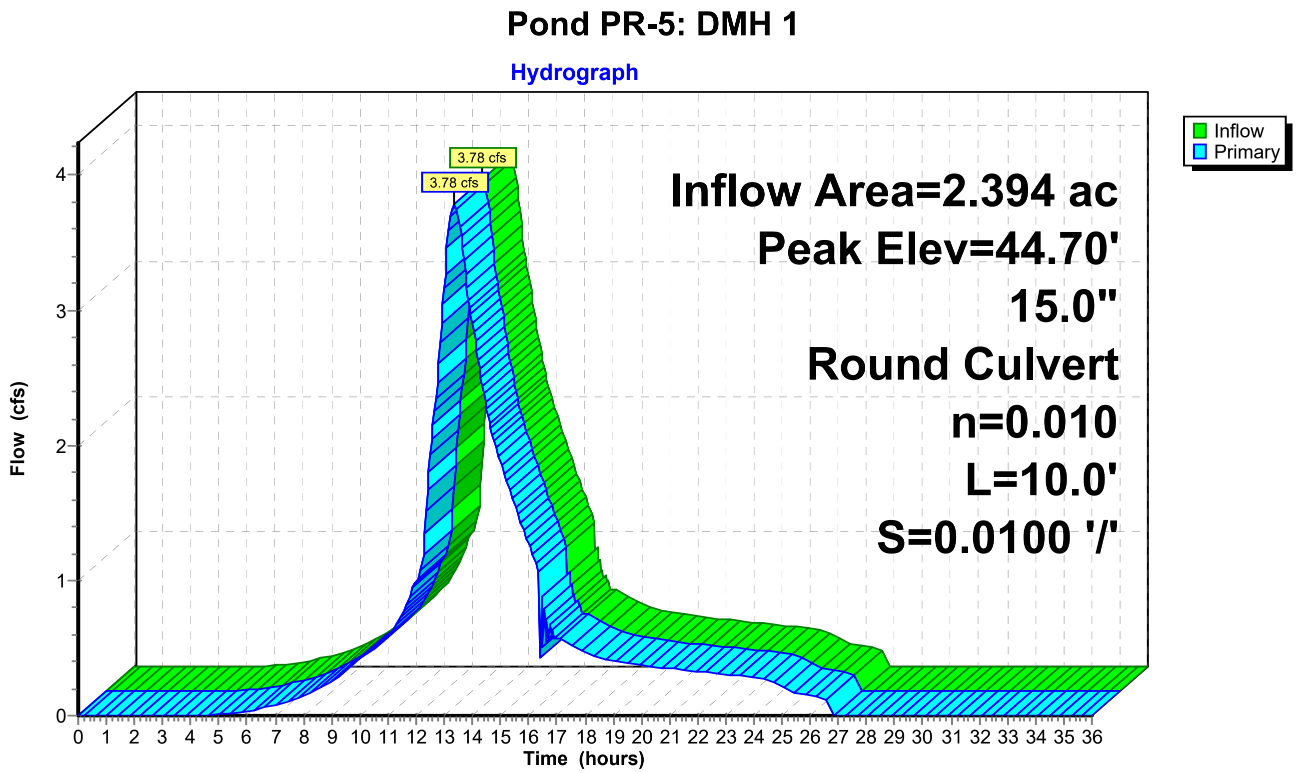
Summary for Pond PR-5: DMH 1

Inflow Area = 2.394 ac, 0.58% Impervious, Inflow Depth = 6.30" for 100 yr event
Inflow = 3.78 cfs @ 13.34 hrs, Volume= 1.258 af
Outflow = 3.78 cfs @ 13.34 hrs, Volume= 1.258 af, Atten= 0%, Lag= 0.0 min
Primary = 3.78 cfs @ 13.34 hrs, Volume= 1.258 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 44.70' @ 13.34 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	43.50'	**15.0" Round Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 43.50' / 43.40' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 1.23 sf

Primary OutFlow Max=3.78 cfs @ 13.34 hrs HW=44.70' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 3.78 cfs @ 4.00 fps)



Summary for Pond SB 01 B: SB 01 B

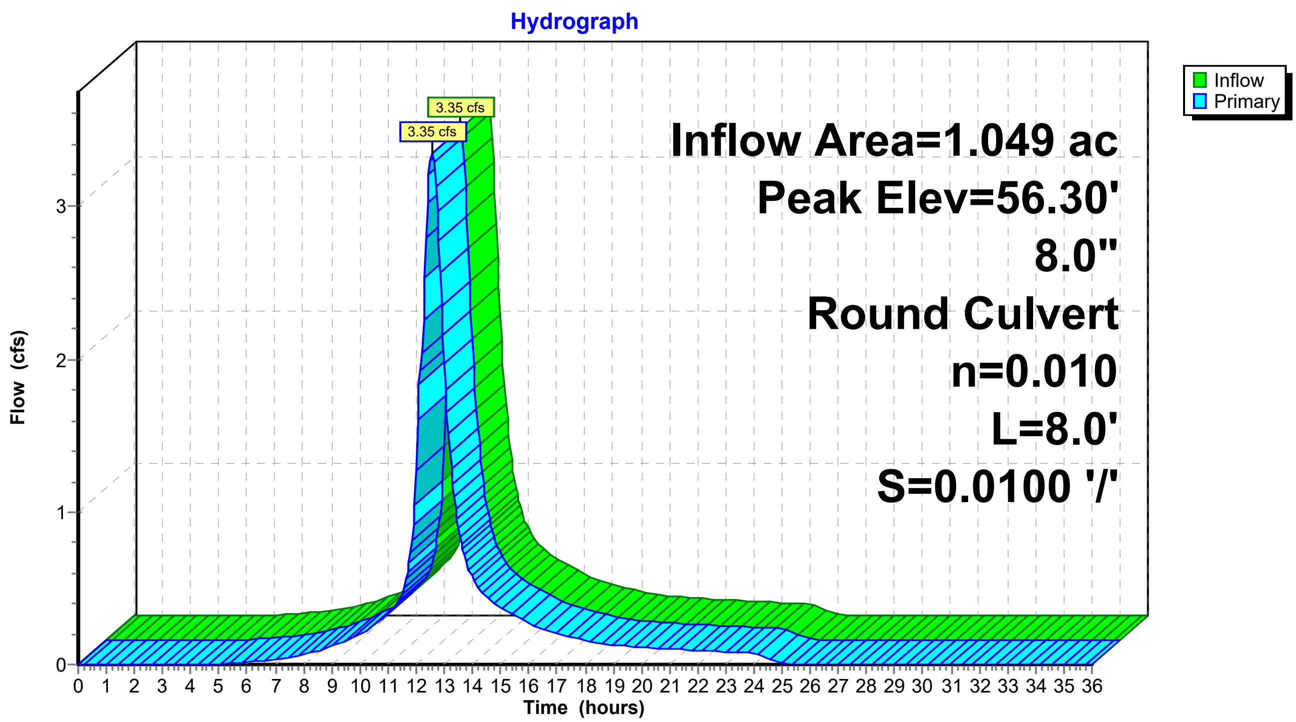
Inflow Area = 1.049 ac, 2.41% Impervious, Inflow Depth = 6.28" for 100 yr event
Inflow = 3.35 cfs @ 12.55 hrs, Volume= 0.549 af
Outflow = 3.35 cfs @ 12.55 hrs, Volume= 0.549 af, Atten= 0%, Lag= 0.0 min
Primary = 3.35 cfs @ 12.55 hrs, Volume= 0.549 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 56.30' @ 12.55 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	52.00'	**8.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 52.00' / 51.92' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.35 sf

Primary OutFlow Max=3.34 cfs @ 12.55 hrs HW=56.29' TW=52.07' (Dynamic Tailwater)
1=Culvert (Inlet Controls 3.34 cfs @ 9.58 fps)

Pond SB 01 B: SB 01 B



Summary for Pond SB 01 S: SB 01 S

Inflow Area = 1.049 ac, 2.41% Impervious, Inflow Depth = 6.28" for 100 yr event
Inflow = 3.35 cfs @ 12.55 hrs, Volume= 0.549 af
Outflow = 2.73 cfs @ 12.81 hrs, Volume= 0.549 af, Atten= 18%, Lag= 15.2 min
Primary = 2.73 cfs @ 12.81 hrs, Volume= 0.549 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 52.36' @ 12.81 hrs Surf.Area= 0 sf Storage= 2,881 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 9.1 min (832.0 - 823.0)

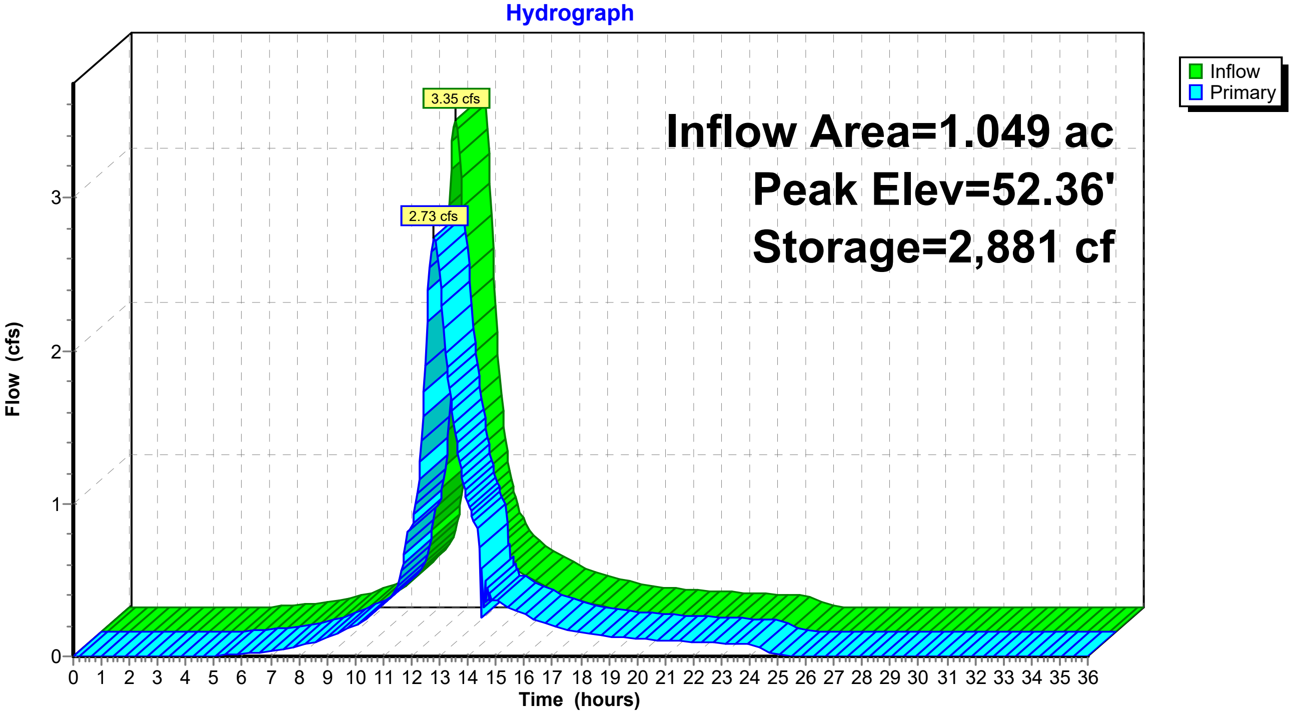
Volume	Invert	Avail.Storage	Storage Description
#1	50.64'	3,084 cf	**Custom Stage Data** Listed below

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
50.64	0	0
51.47	16	16
51.97	2,170	2,186
52.47	898	3,084

Device	Routing	Invert	Outlet Devices
#1	Primary	50.64'	**4.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	50.97'	**6.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	51.47'	**8.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=2.73 cfs @ 12.81 hrs HW=52.36' TW=51.08' (Dynamic Tailwater)
├─**1=Orifice/Grate** (Orifice Controls 0.47 cfs @ 5.44 fps)
├─**2=Orifice/Grate** (Orifice Controls 1.01 cfs @ 5.13 fps)
└─**3=Orifice/Grate** (Orifice Controls 1.25 cfs @ 3.58 fps)

Pond SB 01 S: SB 01 S



Summary for Pond SB 02 B: SB 02 B

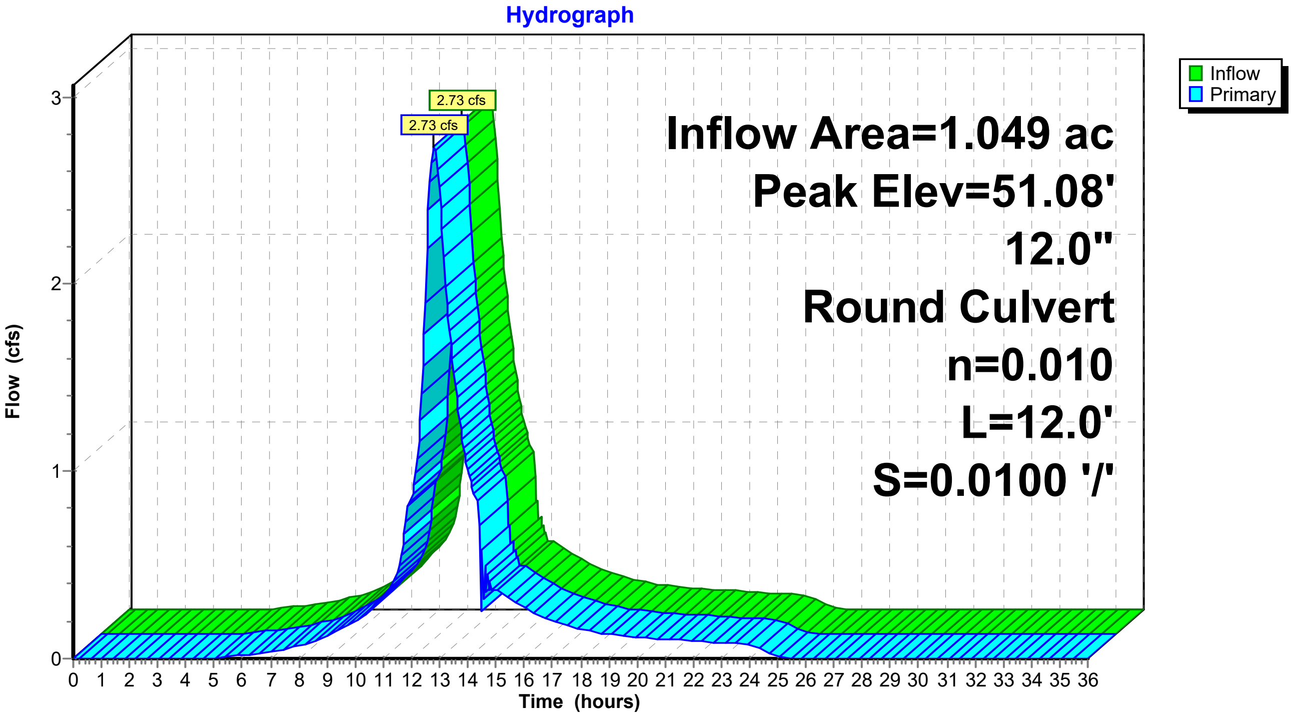
Inflow Area =	1.049 ac,	2.41% Impervious, Inflow Depth = 6.28"	for 100 yr event	
Inflow =	2.73 cfs @	12.81 hrs, Volume=	0.549 af	
Outflow =	2.73 cfs @	12.81 hrs, Volume=	0.549 af,	Atten= 0%, Lag= 0.0 min
Primary =	2.73 cfs @	12.81 hrs, Volume=	0.549 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 51.08' @ 12.81 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	49.97'	**12.0" Round Culvert** L= 12.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 49.97' / 49.85' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=2.73 cfs @ 12.81 hrs HW=51.08' TW=50.56' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 2.73 cfs @ 3.91 fps)

Pond SB 02 B: SB 02 B



Summary for Pond SB 11 B: SB 11 B

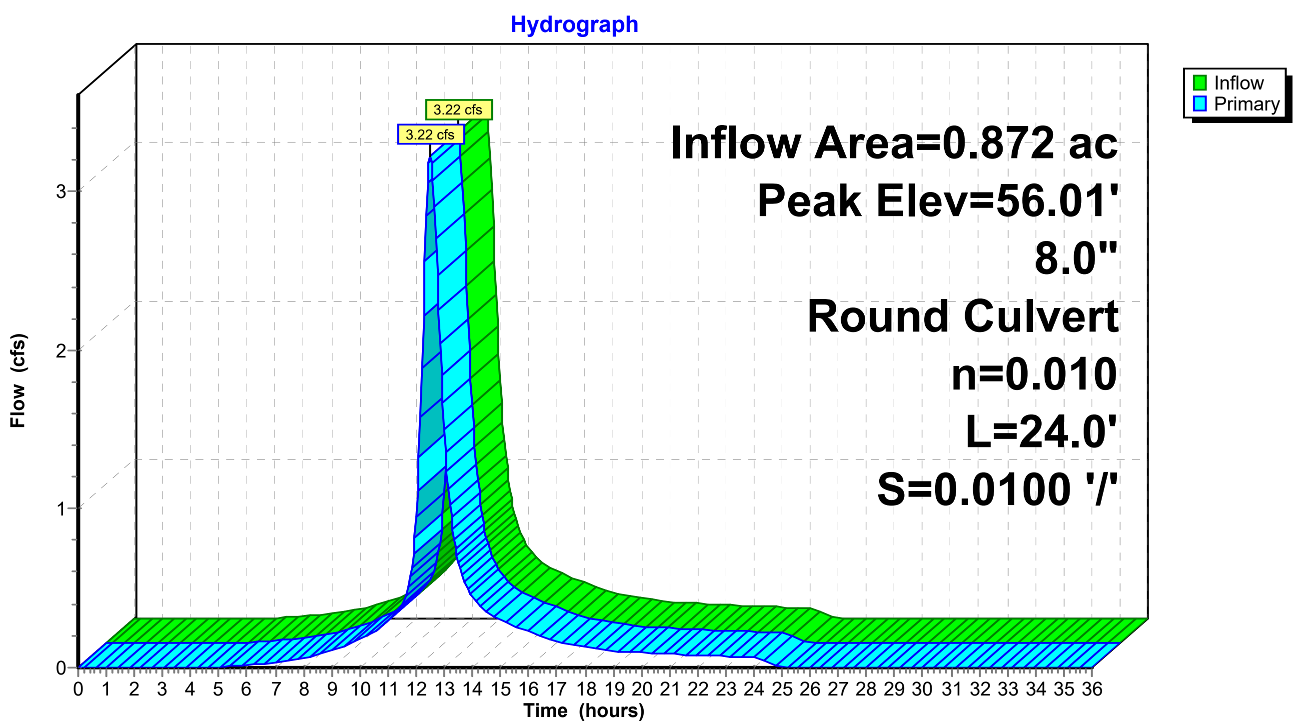
Inflow Area = 0.872 ac, 0.00% Impervious, Inflow Depth = 6.38" for 100 yr event
Inflow = 3.22 cfs @ 12.50 hrs, Volume= 0.464 af
Outflow = 3.22 cfs @ 12.50 hrs, Volume= 0.464 af, Atten= 0%, Lag= 0.0 min
Primary = 3.22 cfs @ 12.50 hrs, Volume= 0.464 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 56.01' @ 12.50 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	52.00'	**8.0" Round Culvert** L= 24.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 52.00' / 51.76' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.35 sf

Primary OutFlow Max=3.22 cfs @ 12.50 hrs HW=56.01' TW=52.14' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 3.22 cfs @ 9.23 fps)

Pond SB 11 B: SB 11 B



Summary for Pond SB 11 S: SB 11 S

Inflow Area = 0.872 ac, 0.00% Impervious, Inflow Depth = 6.38" for 100 yr event
Inflow = 3.22 cfs @ 12.50 hrs, Volume= 0.464 af
Outflow = 2.28 cfs @ 12.78 hrs, Volume= 0.464 af, Atten= 29%, Lag= 16.8 min
Primary = 2.28 cfs @ 12.78 hrs, Volume= 0.464 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 52.58' @ 12.80 hrs Surf.Area= 0 sf Storage= 2,745 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 9.0 min (827.9 - 818.9)

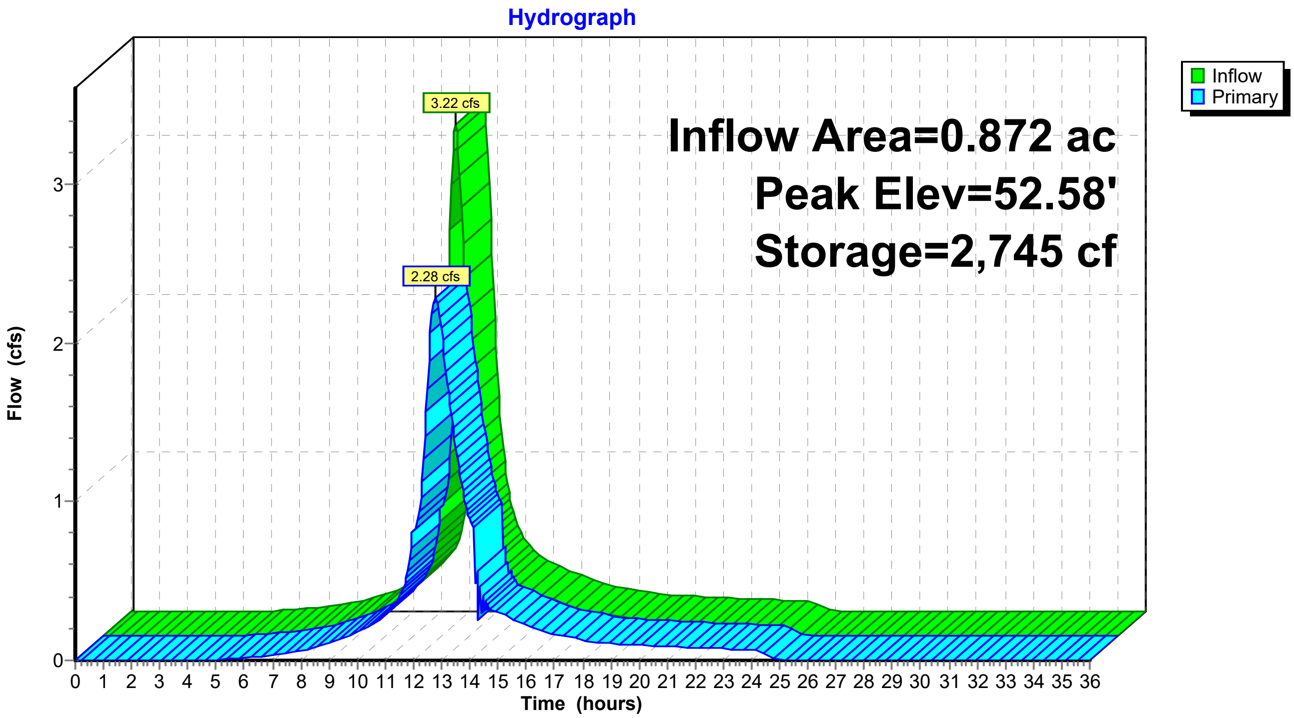
Volume	Invert	Avail.Storage	Storage Description
#1	50.84'	2,892 cf	**Custom Stage Data** Listed below

Elevation (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
50.84	0	0
51.67	16	16
52.17	2,035	2,051
52.67	841	2,892

Device	Routing	Invert	Outlet Devices
#1	Primary	50.84'	**4.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	51.17'	**6.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	51.67'	**6.0" Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=2.28 cfs @ 12.78 hrs HW=52.58' TW=51.22' (Dynamic Tailwater)
├─**1=Orifice/Grate** (Orifice Controls 0.49 cfs @ 5.62 fps)
├─**2=Orifice/Grate** (Orifice Controls 1.02 cfs @ 5.18 fps)
└─**3=Orifice/Grate** (Orifice Controls 0.77 cfs @ 3.91 fps)

Pond SB 11 S: SB 11 S



Summary for Pond SB 12 B: SB 12 B

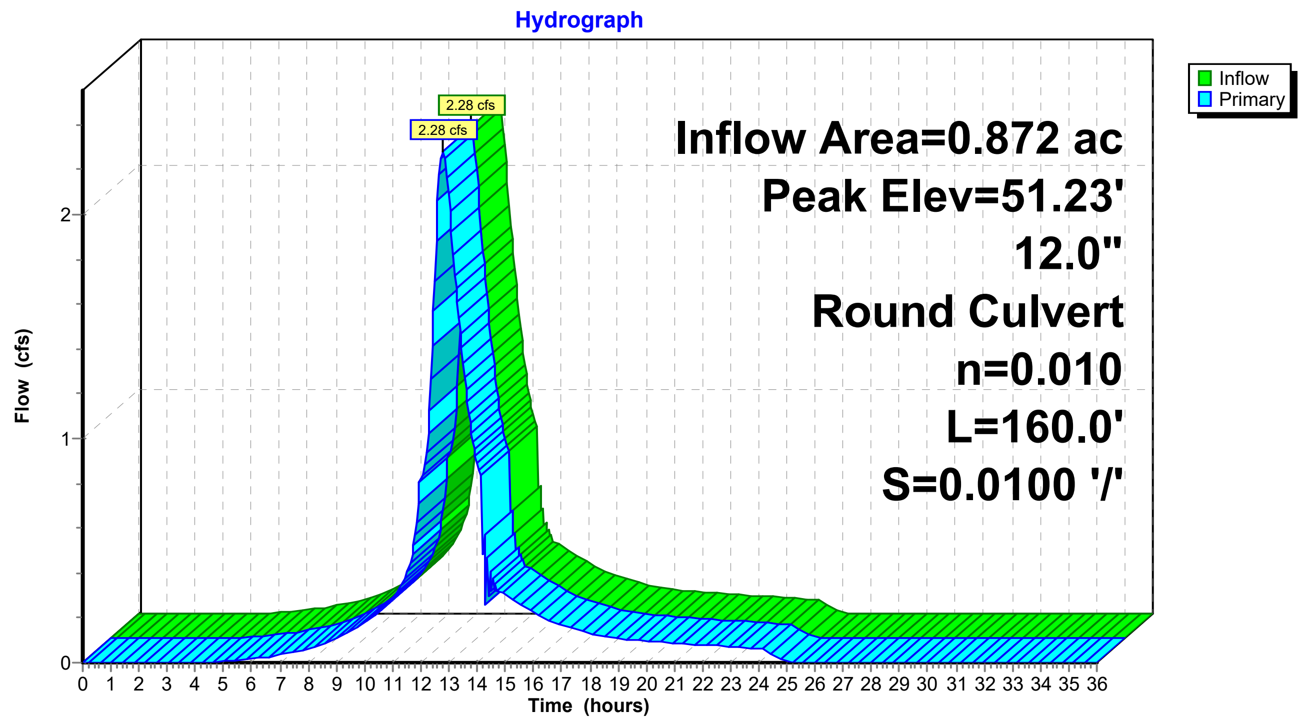
Inflow Area =	0.872 ac,	0.00% Impervious,	Inflow Depth = 6.38"	for 100 yr event	
Inflow =	2.28 cfs @	12.78 hrs,	Volume=	0.464 af	
Outflow =	2.28 cfs @	12.78 hrs,	Volume=	0.464 af,	Atten= 0%, Lag= 0.0 min
Primary =	2.28 cfs @	12.78 hrs,	Volume=	0.464 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 51.23' @ 12.83 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	50.17'	**12.0" Round Culvert** L= 160.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 50.17' / 48.57' S= 0.0100 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf

Primary OutFlow Max=2.22 cfs @ 12.78 hrs HW=51.22' TW=50.55' (Dynamic Tailwater)
└**1=Culvert** (Outlet Controls 2.22 cfs @ 3.36 fps)

Pond SB 12 B: SB 12 B

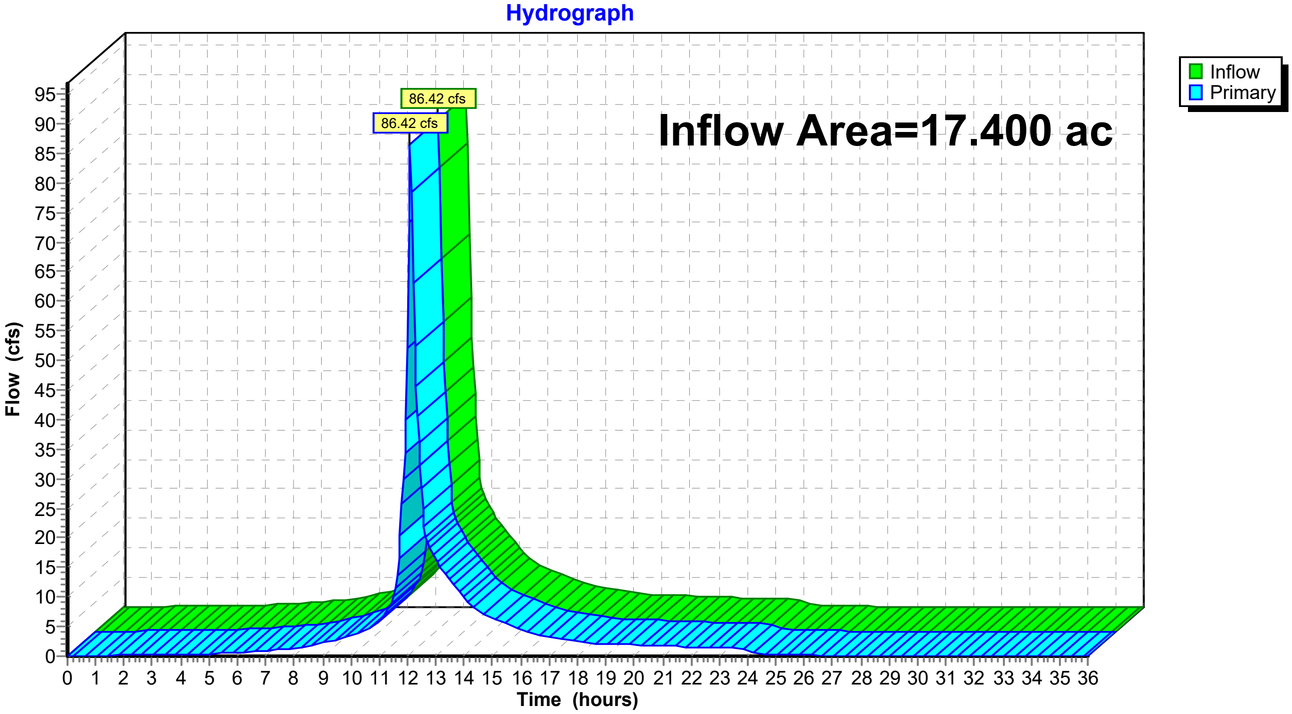


Summary for Link POA: POA

Inflow Area = 17.400 ac, 49.60% Impervious, Inflow Depth > 6.25" for 100 yr event
Inflow = 86.42 cfs @ 12.11 hrs, Volume= 9.057 af
Primary = 86.42 cfs @ 12.11 hrs, Volume= 9.057 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Link POA: POA



APPENDIX 3:
Test Pit Logs
Soils Report

Commonwealth of Massachusetts
City/Town of Arlington

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

A. Facility Information

Town of Arlington
Owner Name

869 Massachusetts Ave — Street Address
53-2-4 — Map/Lot #

Arlington — City
MA — State
02476 — Zip Code

B. Site Information

1. (Check one) ☐ New Construction ☐ Upgrade ☐ Repair

2. Soil Survey Available? ☒ Yes ☐ No If yes: USDA — Source; 656 — Soil Map Unit

   Udorthents — Soil Name
   Soil Limitations:

   Loamy alluvium and/or sandy glaciofluvial deposits and/or loamy glaciolacustrine deposits
   Urban Land — Landform

3. Surficial Geological Report Available? ☒ Yes ☐ No If yes: 2018/Stone — Year Published/Source; Artificial Fill — Map Unit

   Earth materials and manmade materials that have been artificially emplaced.
   Description of Geologic Map Unit:

4. Flood Rate Insurance Map Within a regulatory floodway? ☐ Yes ☒ No

5. Within a velocity zone? ☐ Yes ☒ No

6. Within a Mapped Wetland Area? ☐ Yes ☒ No If yes, MassGIS Wetland Data Layer: N/A — Wetland Type

7. Current Water Resource Conditions (USGS): 1015/19 — Month/Day/ Year Range: ☐ Above Normal ☒ Normal ☐ Below Normal

8. Other references reviewed:

Commonwealth of Massachusetts
City/Town of Arlington

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review *(minimum of two holes required at every proposed primary and reserve disposal area)*

Deep Observation Hole Number: TP-1 (Hole #) | 10/14/19 (Date) | 11:00 (Time) | Sunny, 50's (Weather) | ______ (Latitude) | ______ (Longitude:)

1. Land Use: Landscaped area (e.g., woodland, agricultural field, vacant lot, etc.) | Grass (Vegetation) | None (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | 0-2% (Slope (%))

   Description of Location: ______

2. Soil Parent Material: Loamy alluvium | Outwash plain (Landform) | BS (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body 100'+ feet | Drainage Way 100'+ feet | Wetlands 100'+ feet
   Property Line 20'+ feet | Drinking Water Well 100'+ feet | Other ______ feet

4. Unsuitable Materials Present: ☒ Yes ☐ No If Yes: ☐ Disturbed Soil ☒ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☒ Yes ☐ No If yes: 90" Depth Weeping from Pit 96" Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-36	Fill										
36-48	Ab	Sandy Loam	10YR3/1						Granular	Friable	
48-96	C1	Sandy Loam	2.5Y 5/4				3%	3%	Massive	Friable	

Additional Notes:
NRCS Hydrologic Soil Group B; ESHGW=37.00

Commonwealth of Massachusetts
City/Town of Arlington

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review (*minimum of two holes required at every proposed primary and reserve disposal area*)

Deep Observation Hole Number: ______ Hole # ______ Date ______ Time ______ Weather ______ Latitude ______ Longitude:

1. Land Use: ______ (e.g., woodland, agricultural field, vacant lot, etc.) ______ Vegetation ______ Surface Stones (e.g., cobbles, stones, boulders, etc.) ______ Slope (%)

   Description of Location: ______

2. Soil Parent Material: ______ ______ Landform ______ Position on Landscape (SU, SH, BS, FS, TS)

3. Distances from: Open Water Body ______ feet Drainage Way ______ feet Wetlands ______ feet

   Property Line ______ feet Drinking Water Well ______ feet Other ______ feet

4. Unsuitable Materials Present: ☐ Yes ☐ No If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☐ No If yes: ______ Depth Weeping from Pit ______ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA)	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			

Additional Notes:

Commonwealth of Massachusetts
City/Town of Arlington

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

D. Determination of High Groundwater Elevation

1. Method Used: Obs. Hole # TP-1 Obs. Hole # _____

	Obs. Hole # TP-1	Obs. Hole # _____
☐ Depth observed standing water in observation hole	_____ inches	_____ inches
☒ Depth weeping from side of observation hole	90" inches	_____ inches
☐ Depth to soil redoximorphic features (mottles)	_____ inches	_____ inches
☐ Depth to adjusted seasonal high groundwater (S_h) (USGS methodology)	_____ inches	_____ inches

_____________________ Index Well Number _____________________ Reading Date

$S_h = S_c – [S_r \times (OW_c – OW_{max})/OW_r]$

Obs. Hole/Well# _____ S_c _____ S_r _____ OW_c _____ OW_{max} _____ OW_r _____ S_h _____

2. Estimated Depth to High Groundwater: 90" inches

E. Depth of Pervious Material

1. Depth of Naturally Occurring Pervious Material

a. Does at least four feet of naturally occurring pervious material exist in all areas observed throughout the area proposed for the soil absorption system?

☒ Yes ☐ No

b. If yes, at what depth was it observed (exclude A and O Horizons)? Upper boundary: 48" inches Lower boundary: 96" inches

c. If no, at what depth was impervious material observed? Upper boundary: _____ inches Lower boundary: _____ inches

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F. Certification

I certify that I am currently approved by the Department of Environmental Protection pursuant to 310 CMR 15.017 to conduct soil evaluations and that the above analysis has been performed by me consistent with the required training, expertise and experience described in 310 CMR 15.017. I further certify that the results of my soil evaluation, as indicated in the attached Soil Evaluation Form, are accurate and in accordance with 310 CMR 15.100 through 15.107.

David Scharlacken

Signature of Soil Evaluator

10-15-19

Date

David Scharlacken SE#14279

Typed or Printed Name of Soil Evaluator / License #

12/1/2021

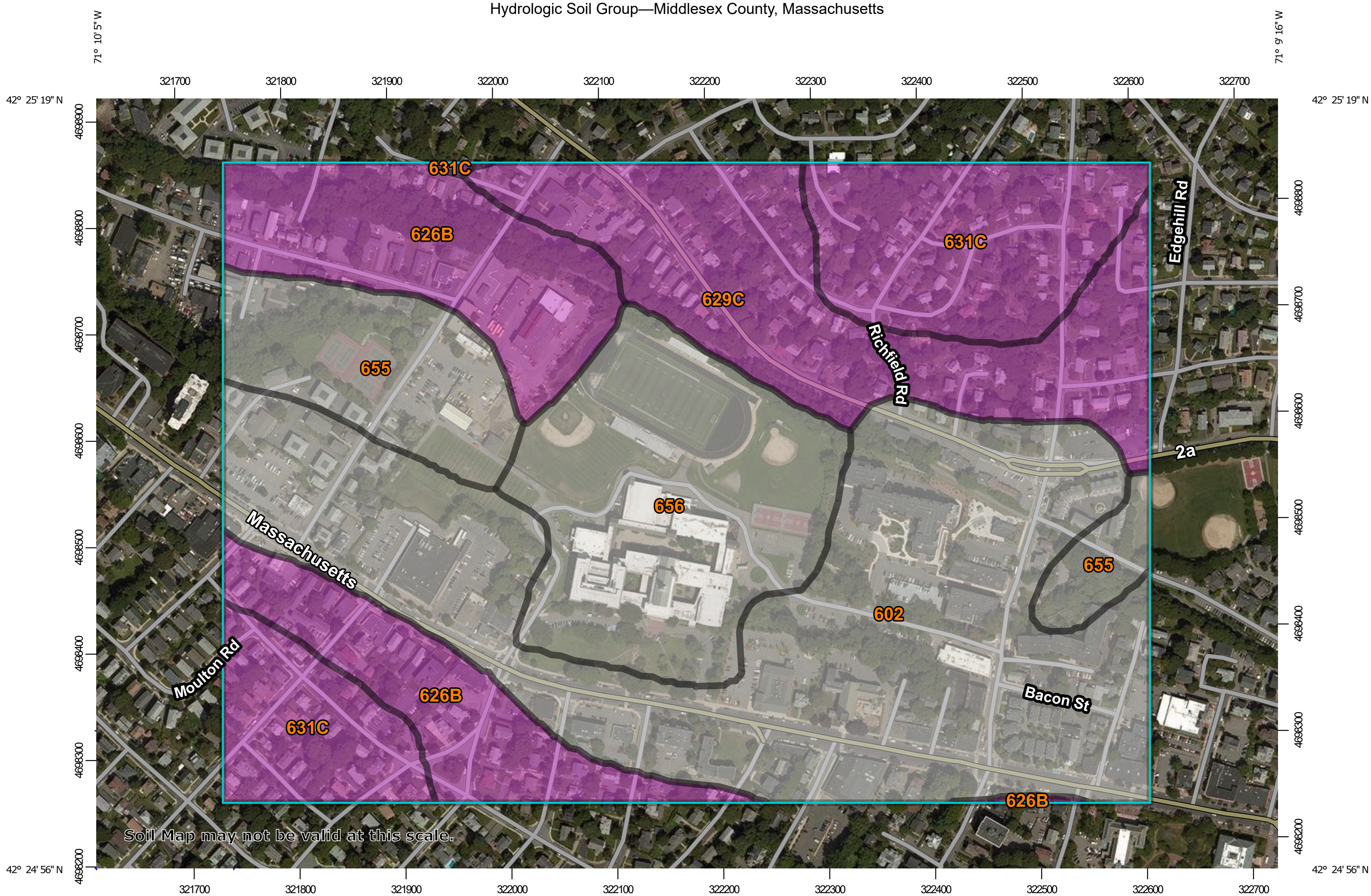
Expiration Date of License

Name of Approving Authority Witness

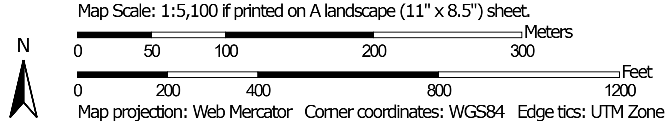
Approving Authority

Note: In accordance with 310 CMR 15.018(2) this form must be submitted to the approving authority within 60 days of the date of field testing, and to the designer and the property owner with Percolation Test Form 12.

Field Diagrams: Use this area for field diagrams:



Map Scale: 1:5,100 if printed on A landscape (11" x 8.5") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:25,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Middlesex County, Massachusetts
Survey Area Data: Version 18, Sep 7, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Aug 10, 2014—Aug 25, 2014

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
602	Urban land		44.3	33.9%
626B	Merrimac-Urban land complex, 0 to 8 percent slopes	A	20.3	15.5%
629C	Canton-Charlton-Urban land complex, 3 to 15 percent slopes	A	18.5	14.1%
631C	Charlton-Urban land-Hollis complex, 3 to 15 percent slopes, rocky	A	17.4	13.3%
655	Udorthents, wet substratum		11.1	8.5%
656	Udorthents-Urban land complex		19.1	14.6%
Totals for Area of Interest			**130.7**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

APPENDIX 4:
Operations and Maintenance Plan

ARLINGTON HIGH SCHOOL
CONSTRUCTION PERIOD POLLUTION PREVENTION PLAN AND EROSION CONTROL OPERATION AND MAINTENANCE PLAN
MAY 2020

During The Construction Period the General Contractor shall be responsible for the following:

1. Erosion Control

Erosion control barriers will be placed along down-gradient portion of the site as indicated on the project plans. Additional erosion control barriers will be placed at the limit of work as needed and in any sensitive areas as work progresses.

A stockpile of additional erosion control barriers shall be kept on site at all times

2. Site Access

Site access, for construction equipment will be from Massachusetts Ave. and Mill Brook Drive via an existing access drive as shown on the phased Demolition and Soil Erosion Plans, and all construction entrances will be installed at the onset of the project.

3. Construction Staging

A construction staging area will be established by the Contractor.

4. Site Grading/Site Work

The site activities may only commence when the site is stable from erosion and all required control measures are in place and functional.

5. Slope Stabilization

All surfaces and slopes shall be checked at least once every 7 calendar days and within 24 hours of the occurrence of a storm event 0.25 inches or greater to see that vegetation is in good condition. Any rills or damage from erosion shall be repaired immediately to avoid further damage. If seeps develop on the slopes, the area will be evaluated to determine if the seep will cause an unstable condition and shall be stabilized immediately if necessary. Problems found during the inspections by the General Contractor shall be repaired promptly. Areas requiring re-vegetation shall be replanted immediately or stabilized in a manner acceptable to the Conservation Commission if it is outside of the growing season. Slopes and other exposed surfaces receiving vegetation will be maintained as necessary to support healthy vegetation. If stabilization is required during the non-growing season, straw mulch, or a commercially manufactured blanket must be employed to prevent erosion.

6. Permanent Stabilization

Disturbed portions of the site where construction activities permanently cease shall be stabilized with permanent seed no later than 14 days after the last construction activity. The permanent seed mix, fertilizer, and mulch shall be specified on the project plans. Permanent seeding shall occur in the Spring or Fall.

7. Drainage Structures (Catch Basins, Area Drains, Manholes, WQU's)

All structures shall be inspected on a bi-weekly basis and/or after every rain storm and repairs made as necessary. Sediment shall be removed from the sump after the sediment has reached a maximum of one half the depth of the sump. The sediment shall be removed from the site and properly disposed of. Drainage structures/sumps shall be cleaned completely at the end of construction.

8. Dust and Sediment Control

Siltsacks:
Catch basin/Area drain filters shall be placed at all inlets to drainage structures as structures are installed and prior to pavement removal. Outlet protection work shall be constructed before runoff is allowed to enter the drainage system. Construction and location of catch basin filters shall be as indicated on the Drawings.

Straw Wattles:
Straw bales shall be installed as indicated on the Drawings.

Bales shall be placed in a row with ends tightly abutting the adjacent wattles. Each roll shall be securely anchored in place by 2 stakes or re-bars driven through the wattles. The first stake in each roll shall be angled toward the previously laid straw wattle to force them together.

Construction Entrance:
The area of the construction entrance should be cleared of all vegetation, roots, and other objectionable material. The filter fabric should be placed on the subgrade prior to the gravel placement. The gravel shall be placed to the specified dimensions depicted on the plans.

The Construction entrance shall be a minimum of 50-feet in length and 20-feet wide.

Dust Control:
A mechanical street sweeper shall be utilized to clean the existing paved areas on an as-needed basis.

For emergency control of dust apply water to affected areas. The source of supply and the method of application for water are the responsibility of the contractor.

Pollution Prevention Measures

1. Before, during, and after construction, functional erosion and sedimentation controls shall be implemented to prevent the silting of the wetland areas down-gradient of the site. Straw bales, crushed stone, temporary stabilization and other controls shall be properly maintained and are not to be removed until the site is permanently stabilized. Other controls shall be added as warranted during construction to protect environmentally-sensitive areas. Sufficient extra materials (e.g. straw bales and other control materials) shall be stored on site for emergencies.

2. Silt sacks and straw bale check dams shall be installed at all existing and proposed infiltration areas to protect from soils and sediment.

3. Casting of excavated materials shall be stored away from wetland areas and sensitive land areas.

4. Any stockpiling of loose materials shall be properly stabilized to prevent erosion and siltation. Preventative controls such as straw wattles, temporary seeding/mulching and jute covering shall be implemented to prevent such an occurrence.

5. There shall be no flooding, ponding, or flood related damage caused by the project or surface run-off emanating from the project on lands of an abutter, nearby or down-gradient of the site.

6. There shall be no contaminant migration caused by the project to nearby and down-gradient properties, nearby aquifers, and nearby resource areas.

7. The contractor shall make sufficient provisions to control any unexpected drainage and erosion conditions that may arise during construction that may create damage on abutting properties. Said control measures are to be implemented at once.

8. During construction flood prevention, erosion, and sedimentation controls shall be in place before the natural ground cover is disturbed. Said controls shall be in place prior to other construction work and shall be monitored and approved by the Contractor. They shall be properly maintained and are not to be removed until the site is stabilized.

9. The Contractor shall designate a person or persons to inspect and supervise the erosion controls for the project. The Conservation Commission shall be notified as to the means to contact said individual or individuals on a 24-hour basis on all working and non-working days of the project. Said means of contact shall include at least 2 separate telephone number of said designated person or persons.

10. There shall be periodic inspection of straw wattles, and other erosion controls by the Contractor's Designee to assure their continued effectiveness.

11. The Contractor shall make adequate provisions for controlling erosion and sediment from activities that might yield water at high volumes with high suspended solid contents, such as dewatering excavations.

12. Street sweeping shall be used to keep public ways free and clear of sediment and dirt from the site activities.

Other Control Measures

Waste Materials. All trash and construction debris from the site will be hauled to an approved landfill or recycling facility. No construction waste material will be buried on the site. All personnel will receive instructions regarding the correct procedure for waste disposal. Notices describing these practices will be posted in the construction office. The site superintendent will be responsible for seeing that these procedures are followed. Employee waste and other loose materials will be collected so as to prevent the release of floatables during rainfall events.

Hazardous Waste. No Hazardous materials are expected to be encountered. The mandated State and Local permits for removal of such materials, if located, will be implemented when such materials are encountered.

After Construction, the owner shall be responsible for the following:

General Land Grading and Slopes Stabilization

All surfaces and slopes shall be checked bi-annually to see that vegetation is in good condition. Any rills or damage from erosion shall be repaired immediately to avoid further damage. If seeps develop on the slopes, the area will be evaluated to determine if the seep will cause an unstable condition and shall be stabilized immediately if necessary. Problems found during the inspections by the Owner shall be repaired promptly. Areas requiring re-vegetation shall be replanted immediately. Slopes and other exposed surfaces receiving vegetation will be maintained as necessary to support healthy vegetation.

Areas of steep slopes (2.5:1 or greater) shall be stabilized using jute mesh or a similar approved erosion blanket.

Erosion Controls

Erosion controls shall not be removed or dismantled without approval from the Engineer or Conservation Commission. Sediment deposits that are removed or left in place after the barriers have been dismantled shall be graded manually to conform to the existing topography and vegetated using seeding or other long term cover as approved in the Landscape Plan. Bare ground that cannot be permanently stabilized within 30 days shall be stabilized by temporary measures.

Street Sweeping ($500 per sweeping)

It is proposed that the parking and drive areas be swept with a wet brush street sweeper on a semi-annual basis, with at least two sweepings per year. One sweep shall be done at the end of the winter season (prior to the heavy rains), and the other sweep at the end of autumn (prior to snowfall).

Stormwater Management System

Catch Basins, Area Drains, and Drain Manholes ($500 per CB structure per inspection/cleaning):
The catch basins, drain manholes, WQU's, infiltration systems, and area drains shall be inspected semi-annually, and cleaned out when sumps are approximately one foot full. The use of "clam shells" for sediment removal shall not be allowed; a vacuum truck shall be the approved method of cleaning. Integrity and functionality of oil hoods shall also be checked at the time of the inspection.

Water Quality Unit (WQU) ($1000 per structure per inspection/cleaning):
Water Quality Unit shall be as follows and per manufacturer's recommendations:

- Units should be inspected post-construction, prior to being put into service.
- Inspect every six months for the first year of operation to determine the oil and sediment accumulation rate. In subsequent years, inspections can be based on first-year observations
- Cleaning is required once the sediment depth reaches 15% of storage capacity, (generally taking one year or longer).
- Inspect the unit immediately after an oil, fuel or chemical spill.
- A licensed waste management company should remove captured petroleum waste products from any oil, chemical or fuel spills and dispose responsibly

Rain Garden ($750 per cleaning):
Inspection and Maintenance of Rain Gardens shall be conducted per the Bioretention Maintenance Schedule provided below from the Massachusetts Stormwater Handbook:

Bioretention Maintenance Schedule		
Activity	***Time of Year***	***Frequency***
Inspect & remove trash	Year round	Monthly
Mulch	Spring	Annually
Remove dead vegetation	Fall or Spring	Annually
Replace dead vegetation	Spring	Annually
Prune	Spring or Fall	Annually
Replace entire media & all vegetation	Late Spring/early Summer	As needed*

** Paying careful attention to pretreatment and operation & maintenance can extend the life of the soil media*

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Infiltration System ($2,500 per cleaning; $1,000 per inspection)

The proposed infiltration system shall be inspected semi-annually, and shall follow the suggested schedule for routine maintenance during the regular operation of the stormwater system:

Inlets and Outlets	Every 3 years	• Obtain documentation that the inlets, outlets and vents have been cleaned and will function as intended.
	Spring and Fall	• Check inlet and outlets for clogging and remove any debris as required.
Stormwater Chambers	2 years after commissioning	• Inspect the interior of the stormwater management chambers through inspection port for deficiencies using CCTV or comparable technique. • Obtain documentation that the stormwater management chambers and feed connectors will function as anticipated.
	9 years after commissioning every 9 years following	• Clean stormwater management chambers and feed connectors of any debris. • Inspect the interior of the stormwater management structures for deficiencies using CCTV or comparable technique. • Obtain documentation that the stormwater management chambers and feed connectors have been cleaned and will function as intended.
	45 years after commissioning	• Clean stormwater management chambers and feed connectors of any debris. • Determine the remaining life expectancy of the stormwater management chambers and recommended schedule and actions to rehabilitate the stormwater management chambers as required. • Inspect the interior of the stormwater management chambers for deficiencies using CCTV or comparable technique. • Replace or restore the stormwater management chambers in accordance with the schedule determined at the 45-year inspection. • Attain the appropriate approvals as required. • Establish a new operation and maintenance schedule.
Surrounding Site	Monthly in 1st year	• Check for depressions in areas over and surrounding the stormwater management system.
	Spring and Fall	• Check for depressions in areas over and surrounding the stormwater management system.
	Yearly	• Confirm that no unauthorized modifications have been performed to the site.

Maintenance and Emergency Repairs

Any maintenance or emergency repairs to the system will be the responsibility of the Owner.

INSPECTION REPORT FORM FOR STORM WATER SYSTEM

Project: Arlington High School, Arlington, MA
869 Massachusetts Avenue, Arlington, MA 02476

INSPECTOR:______________________________**DATE:**____________________________

Regular Inspection: ☐
Inspection after Rainfall: ☐ **Amount of Rainfall:**______**inches**

BMP	Functioning Correctly	Notes/Action Taken
	Y/N	
	Y/N	
	Y/N	
	Y/N	
	Y/N	
	Y/N	
	Y/N	

Additional Observations: ____

Action Required: ____

To be performed by:______________________________**On or Before:**________________

APPENDIX 5:
Calculations

NOAA Atlas 14, Volume 10, Version 3
Location name: Arlington, Massachusetts, USA*
Latitude: 42.4182°, Longitude: -71.1617°
Elevation: 49.76 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.304 (0.236-0.386)	0.373 (0.289-0.474)	0.485 (0.376-0.619)	0.578 (0.445-0.742)	0.705 (0.526-0.953)	0.800 (0.586-1.11)	0.901 (0.644-1.30)	1.02 (0.687-1.50)	1.20 (0.779-1.84)	1.36 (0.858-2.11)
10-min	0.431 (0.335-0.547)	0.528 (0.410-0.671)	0.686 (0.531-0.876)	0.817 (0.629-1.05)	0.998 (0.746-1.35)	1.13 (0.830-1.57)	1.28 (0.913-1.85)	1.45 (0.974-2.13)	1.70 (1.10-2.60)	1.92 (1.22-2.99)
15-min	0.507 (0.394-0.644)	0.621 (0.482-0.790)	0.808 (0.625-1.03)	0.962 (0.740-1.24)	1.18 (0.877-1.59)	1.33 (0.976-1.85)	1.50 (1.07-2.17)	1.70 (1.15-2.51)	2.00 (1.30-3.06)	2.26 (1.43-3.52)
30-min	0.694 (0.539-0.881)	0.851 (0.661-1.08)	1.11 (0.858-1.41)	1.32 (1.02-1.70)	1.62 (1.21-2.19)	1.84 (1.35-2.55)	2.07 (1.48-3.00)	2.35 (1.58-3.47)	2.78 (1.80-4.25)	3.15 (1.99-4.91)
60-min	0.881 (0.685-1.12)	1.08 (0.840-1.38)	1.41 (1.09-1.80)	1.68 (1.30-2.16)	2.06 (1.54-2.79)	2.34 (1.72-3.25)	2.64 (1.89-3.83)	3.00 (2.02-4.42)	3.56 (2.31-5.44)	4.04 (2.56-6.31)
2-hr	1.15 (0.897-1.45)	1.41 (1.10-1.78)	1.84 (1.43-2.33)	2.19 (1.70-2.80)	2.69 (2.02-3.62)	3.05 (2.26-4.21)	3.44 (2.49-4.98)	3.94 (2.66-5.75)	4.71 (3.06-7.14)	5.39 (3.42-8.33)
3-hr	1.34 (1.05-1.68)	1.64 (1.29-2.06)	2.14 (1.67-2.70)	2.55 (1.99-3.24)	3.12 (2.36-4.19)	3.54 (2.63-4.88)	4.00 (2.91-5.78)	4.59 (3.10-6.66)	5.50 (3.58-8.28)	6.30 (4.01-9.68)
6-hr	1.73 (1.37-2.16)	2.12 (1.68-2.65)	2.76 (2.17-3.46)	3.29 (2.57-4.15)	4.02 (3.06-5.34)	4.55 (3.40-6.21)	5.14 (3.75-7.35)	5.88 (3.99-8.46)	7.04 (4.59-10.5)	8.05 (5.13-12.2)
12-hr	2.20 (1.76-2.73)	2.70 (2.15-3.35)	3.51 (2.78-4.37)	4.18 (3.29-5.23)	5.10 (3.90-6.73)	5.78 (4.34-7.81)	6.52 (4.78-9.22)	7.44 (5.07-10.6)	8.86 (5.81-13.1)	10.1 (6.46-15.2)
24-hr	2.64 (2.12-3.25)	3.28 (2.63-4.04)	4.31 (3.44-5.33)	5.17 (4.10-6.43)	6.35 (4.89-8.32)	7.22 (5.46-9.69)	8.17 (6.02-11.5)	9.36 (6.41-13.2)	11.2 (7.38-16.4)	12.8 (8.24-19.1)
2-day	3.01 (2.43-3.68)	3.80 (3.07-4.65)	5.10 (4.10-6.26)	6.17 (4.93-7.62)	7.65 (5.94-9.98)	8.73 (6.66-11.7)	9.93 (7.40-13.9)	11.5 (7.89-16.1)	14.0 (9.22-20.3)	16.2 (10.4-23.9)
3-day	3.30 (2.68-4.01)	4.15 (3.37-5.06)	5.55 (4.48-6.78)	6.71 (5.38-8.24)	8.30 (6.47-10.8)	9.46 (7.25-12.6)	10.8 (8.05-15.0)	12.5 (8.57-17.3)	15.2 (10.0-21.9)	17.6 (11.4-25.9)
4-day	3.57 (2.91-4.33)	4.45 (3.62-5.41)	5.90 (4.78-7.19)	7.09 (5.71-8.69)	8.74 (6.83-11.3)	9.94 (7.63-13.2)	11.3 (8.46-15.7)	13.0 (8.99-18.1)	15.9 (10.5-22.8)	18.4 (11.9-26.9)
7-day	4.33 (3.55-5.23)	5.25 (4.30-6.34)	6.75 (5.50-8.18)	8.00 (6.48-9.74)	9.71 (7.63-12.5)	11.0 (8.44-14.4)	12.4 (9.28-17.0)	14.2 (9.81-19.5)	17.1 (11.3-24.3)	19.6 (12.7-28.4)
10-day	5.03 (4.14-6.05)	5.98 (4.91-7.19)	7.52 (6.15-9.08)	8.80 (7.15-10.7)	10.6 (8.31-13.5)	11.9 (9.14-15.5)	13.3 (9.96-18.1)	15.1 (10.5-20.6)	17.9 (11.9-25.3)	20.4 (13.2-29.4)
20-day	7.03 (5.83-8.39)	8.06 (6.67-9.63)	9.74 (8.03-11.7)	11.1 (9.12-13.4)	13.1 (10.3-16.4)	14.5 (11.2-18.6)	16.0 (11.9-21.2)	17.8 (12.4-24.0)	20.3 (13.6-28.4)	22.4 (14.6-31.9)
30-day	8.69 (7.23-10.3)	9.78 (8.13-11.6)	11.6 (9.58-13.8)	13.1 (10.7-15.7)	15.1 (11.9-18.8)	16.7 (12.8-21.1)	18.2 (13.5-23.8)	19.9 (14.0-26.8)	22.2 (14.9-30.9)	24.0 (15.7-34.1)
45-day	10.8 (9.01-12.8)	11.9 (9.97-14.1)	13.8 (11.5-16.5)	15.4 (12.7-18.4)	17.6 (13.9-21.7)	19.3 (14.9-24.2)	20.9 (15.5-27.0)	22.6 (15.9-30.1)	24.7 (16.6-34.0)	26.2 (17.1-36.9)
60-day	12.6 (10.5-14.8)	13.8 (11.5-16.3)	15.8 (13.1-18.7)	17.4 (14.4-20.7)	19.7 (15.6-24.1)	21.5 (16.6-26.7)	23.2 (17.1-29.6)	24.8 (17.5-32.9)	26.7 (18.0-36.7)	28.1 (18.4-39.4)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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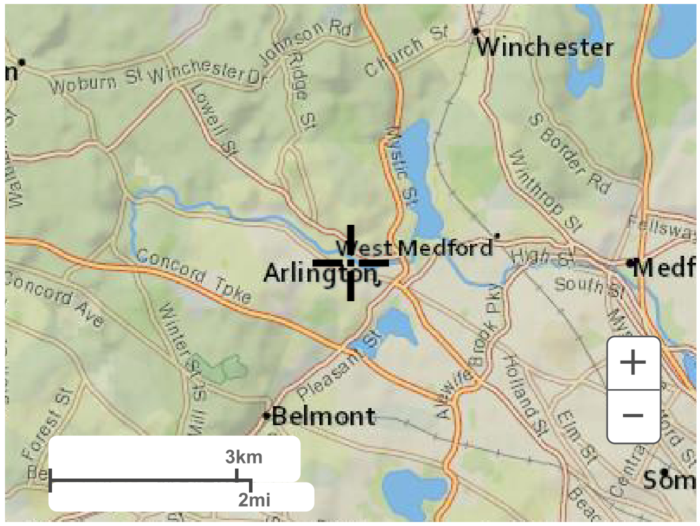
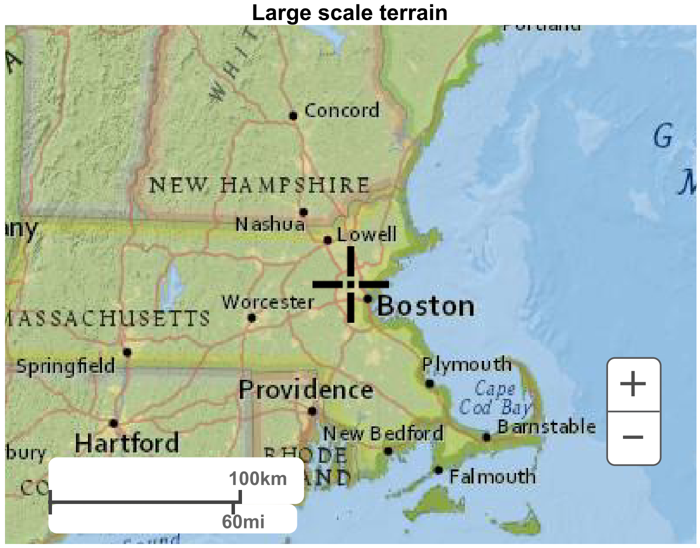
PF graphical



Large scale terrain



Large scale map

Large scale aerial

STORM DRAIN COMPUTATION SHEET 5/7/2020

Section 1: Direct Inlet "Branch" Segments (Area Drains, Catch Basins, etc.)

SEGMENT			WATERSHED CHARACTERISTICS					PIPE CHARACTERISTICS				MANNING'S VALUES					
			Design Frequency		25-year							Pipe Design Depth			1.00 D		
No.	Start	End	Drain. Area acres	Runoff Coeff.	Time of Conc. min	Rainfall Intens. in/hr	Q (min) CiA cfs	Pipe Diameter D in	Pipe Material	Pipe Length ft	Pipe Slope	n	A sf	R ft	Q (max)	Head above invert ft	Velocity fps
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
1	CB1	DMH1	0.123	0.95	6.0	5.90	**0.70**	12	HDPE	177	0.015	0.011	0.785	0.250	**5.17**	-	0.0 fps
2	CB2	DMH1	0.117	0.95	6.0	5.90	**0.66**	12	HDPE	6	0.010	0.011	0.785	0.250	**4.22**	-	3.6 fps
3	CB3	DMH12	0.443	0.58	6.0	5.90	**1.54**	12	HDPE	171	0.005	0.011	0.785	0.250	**2.99**	-	4.0 fps
4	CB4	RG2	0.372	0.95	6.0	5.90	**2.31**	12	HDPE	128	0.050	0.011	0.785	0.250	**9.44**	-	9.4 fps
5	CB5	DMH3	0.474	0.90	6.0	5.90	**2.53**	12	HDPE	183	0.050	0.010	0.785	0.250	**10.38**	-	11.5 fps
6	CB6	DMH11	0.305	0.80	6.0	5.90	**1.45**	12	HDPE	52	0.042	0.011	0.785	0.250	**8.65**	-	7.7 fps
7	CB7	DMH11	0.641	0.94	6.0	5.90	**3.57**	12	HDPE	60	0.009	0.011	0.785	0.250	**4.01**	-	5.1 fps
8	CB8	WQU1	0.200	0.95	6.0	5.90	**1.13**	12	HDPE	11	0.020	0.011	0.785	0.250	**5.97**	-	7.6 fps
9	CB9	WQU1	0.157	0.80	6.0	5.90	**0.74**	12	HDPE	76	0.010	0.011	0.785	0.250	**4.22**	-	5.4 fps
10	CB10	DMH3	0.502	0.86	6.0	5.90	**2.57**	12	HDPE	21	0.030	0.011	0.785	0.250	**7.31**	-	9.3 fps
11	CB11	DMH5	0.727	0.57	6.0	5.90	**2.49**	12	HDPE	47	0.010	0.011	0.785	0.250	**4.22**	-	5.4 fps
12	CB12	DMH7	1.070	0.70	6.0	5.90	**4.43**	12	HDPE	46	0.020	0.011	0.785	0.250	**5.97**	-	7.6 fps
13	CB13	MILL BRK	0.309	0.84	6.0	5.90	**1.55**	12	HDPE	45	0.030	0.011	0.785	0.250	**7.31**	-	9.3 fps
14	TD-2	DMH2	0.237	0.92	6.0	5.90	**1.29**	12	HDPE	107	0.010	0.011	0.785	0.250	**4.22**	-	5.4 fps
15	AD-3	DMH1	0.101	0.42	6.0	5.90	**0.25**	8	HDPE	48	0.005	0.011	0.349	0.167	**1.01**	-	2.9 fps
16	AD-5	DMH14	0.034	0.95	6.0	5.90	**0.19**	8	HDPE	20	0.100	0.011	0.349	0.167	**4.53**	-	13.0 fps
17	AD-6	DMH4	0.046	0.52	6.0	5.90	**0.14**	8	HDPE	5	0.010	0.011	0.349	0.167	**1.43**	-	4.1 fps
18	AD-7	DMH5	0.023	0.25	6.0	5.90	**0.03**	8	HDPE	12	0.010	0.011	0.349	0.167	**1.43**	-	4.1 fps
19	RD-1	DMH13	0.656	0.95	6.0	5.90	**3.71**	12	HDPE	150	0.010	0.011	0.785	0.250	**4.22**	-	5.4 fps
20	RD-2	DMH13	0.576	0.95	6.0	5.90	**3.25**	12	HDPE	14	0.025	0.011	0.785	0.250	**6.68**	-	8.5 fps
21	RD-3	DMH8	0.232	0.95	6.0	5.90	**1.31**	10	HDPE	20	0.030	0.011	0.545	0.208	**4.50**	-	8.2 fps
22	RD-4	DMH6	0.862	0.95	6.0	5.90	**4.87**	12	HDPE	52	0.020	0.011	0.785	0.250	**5.97**	-	7.6 fps
23	RD-5	DMH5	0.709	0.95	6.0	5.90	**4.01**	12	HDPE	49	0.010	0.011	0.785	0.250	**4.22**	-	5.4 fps
24	RD-6	DMH4	0.333	0.95	6.0	5.90	**1.88**	12	HDPE	8	0.010	0.011	0.785	0.250	**4.22**	-	5.4 fps
25	RD-7	DMH14	0.186	0.95	6.0	5.90	**1.05**	12	HDPE	7	0.010	0.011	0.785	0.250	**4.22**	-	5.4 fps
26	AD15	DMH3	0.307	0.22	6.0	5.90	**0.40**	6	PVC	106	0.015	0.010	0.196	0.125	**0.90**	-	4.6 fps
27	AD10	DMH8	0.132	0.71	6.0	5.90	**0.56**	6	PVC	200	0.016	0.010	0.196	0.125	**0.93**	-	4.7 fps

STORM DRAIN COMPUTATION SHEET

Section 2: Main Line "Trunk" Segments (Drain Basins, Manholes, etc.)

SEGMENT			WATERSHED CHARACTERISTICS	PIPE CHARACTERISTICS				MANNING'S VALUES					
			Design Frequency 25-year					Pipe Design Depth			1.00 D		
No.	Start	End	Q (min)	Pipe Diameter	Pipe Material	Pipe Length	Pipe Slope	n	A	R	Q (max)	Head above invert	Velocity
1	DMH1	DMH2	**1.36**	12	HDPE	46	0.010	0.011	0.785	0.250	**4.22**	-	4.6 fps
2	DMH2	RG1	**2.65**	12	HDPE	99	0.050	0.011	0.785	0.250	**9.44**	-	9.7 fps
3	DMH14	DMH3	**1.24**	12	HDPE	33	0.010	0.011	0.785	0.250	**4.22**	-	4.4 fps
4	DMH3	DMH4	**10.18**	24	HDPE	81	0.005	0.011	3.142	0.500	**18.96**	-	6.2 fps
5	DMH4	DMH5	**12.20**	24	HDPE	90	0.005	0.011	3.142	0.500	**18.96**	-	6.5 fps
6	DMH5	DMH6	**21.10**	30	HDPE	108	0.005	0.011	4.909	0.625	**34.37**	-	7.5 fps
7	DMH6	DMH7	**25.97**	30	HDPE	74	0.005	0.011	4.909	0.625	**34.37**	-	7.0 fps
8	DMH7	DMH8	**30.39**	30	HDPE	115	0.005	0.011	4.909	0.625	**34.37**	-	7.0 fps
9	DMH8	DMH9	**32.27**	30	HDPE	90	0.005	0.011	4.909	0.625	**34.37**	-	7.0 fps
10	DMH11	DMH10	**5.02**	15	HDPE	20	0.005	0.011	1.227	0.313	**5.41**	-	4.4 fps
11	DMH10	UGS1	**6.57**	18	HDPE	4	0.005	0.011	1.767	0.375	**8.80**	-	5.6 fps
12	WQU1	MILL BRK	**1.87**	12	HDPE	11	0.020	0.011	0.785	0.250	**5.97**	-	7.6 fps
13	DMH13	DMH15	**6.96**	12	HDPE	62	0.030	0.011	0.785	0.250	**7.31**	-	9.3 fps
14	DMH15	DMH12	**6.96**	12	HDPE	47	0.240	0.011	0.785	0.250	**20.68**	-	26.3 fps
15	DMH12	DMH16	**6.96**	12	HDPE	82	0.130	0.011	0.785	0.250	**15.22**	-	19.4 fps
16	DMH16	DMH17	**6.96**	15	HDPE	70	0.027	0.011	1.227	0.313	**12.58**	-	10.2 fps
17	DMH17	DMH18	**6.96**	15	HDPE	80	0.025	0.011	1.227	0.313	**12.10**	-	9.9 fps

Stage-Area-Storage for Pond 5P: rain garden#1 cascading

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
58.50	150	0
58.55	150	3
58.60	150	6
58.65	150	9
58.70	150	12
58.75	150	15
58.80	150	18
58.85	150	21
58.90	150	24
58.95	150	27
59.00	150	30
59.05	150	32
59.10	150	34
59.15	150	36
59.20	150	38
59.25	150	39
59.30	150	41
59.35	150	43
59.40	150	45
59.45	150	47
59.50	150	49
59.55	150	51
59.60	150	53
59.65	150	54
59.70	150	56
59.75	150	58
59.80	150	60
59.85	150	62
59.90	150	64
59.95	150	66
60.00	150	68
60.05	150	69
60.10	150	71
60.15	150	73
60.20	150	75
60.25	150	77
60.30	150	79
60.35	150	80
60.40	150	82
60.45	150	83
60.50	150	85
60.55	159	93
60.60	167	101
60.65	176	109
60.70	184	118
60.75	193	128
60.80	202	138
60.85	210	148
60.90	219	159
60.95	227	170
61.00	236	181
61.05	249	194

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)	
61.10	263	206	
61.15	276	220	
61.20	289	234	
61.25	303	249	
61.30	316	264	
61.35	329	280	
61.40	343	297	
61.45	356	315	
61.50	370	333	
61.55	383	352	
61.60	396	371	
61.65	410	391	
61.70	423	412	
61.75	436	434	
61.80	450	456	
61.85	463	479	
61.90	476	502	
61.95	490	526	
62.00	503	551	STATIC STORAGE
62.05	511	576	
62.10	519	602	
62.15	527	628	
62.20	534	655	
62.25	542	682	
62.30	550	709	
62.35	558	737	
62.40	566	765	
62.45	574	793	
62.50	582	822	
62.55	589	851	
62.60	597	881	
62.65	605	911	
62.70	613	942	
62.75	621	972	
62.80	629	1,004	
62.85	636	1,035	
62.90	644	1,067	
62.95	652	1,100	
63.00	**660**	**1,132**	

Stage-Area-Storage for Pond 2P: rain garden#2 cascading

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)	
51.00	400	0	
51.05	400	8	
51.10	400	16	
51.15	400	24	
51.20	400	32	
51.25	400	40	
51.30	400	48	
51.35	400	56	
51.40	400	64	
51.45	400	72	
51.50	400	80	
51.55	400	85	
51.60	400	90	
51.65	400	95	
51.70	400	100	
51.75	400	105	
51.80	400	110	
51.85	400	115	
51.90	400	120	
51.95	400	125	
52.00	400	130	
52.05	400	135	
52.10	400	140	
52.15	400	145	
52.20	400	150	
52.25	400	155	
52.30	400	160	
52.35	400	165	
52.40	400	170	
52.45	400	175	
52.50	400	180	
52.55	400	185	
52.60	400	190	
52.65	400	195	
52.70	400	200	
52.75	400	205	
52.80	400	210	
52.85	400	215	
52.90	400	219	
52.95	400	223	
53.00	400	227	
53.05	415	247	
53.10	429	268	
53.15	444	290	
53.20	459	312	
53.25	474	336	
53.30	488	360	
53.35	503	385	
53.40	518	410	
53.45	532	436	
53.50	547	463	
53.55	562	491	
53.60	576	520	
53.65	591	549	
53.70	606	579	
53.75	621	609	
53.80	635	641	
53.85	650	673	
53.90	665	706	
53.95	679	739	
54.00	694	774	
54.05	726	809	
54.10	757	846	
54.15	789	885	
54.20	820	925	
54.25	852	967	
54.30	884	1,010	
54.35	915	1,055	
54.40	947	1,102	
54.45	978	1,150	
54.50	1,010	1,200	STATIC STORAGE
54.55	1,042	1,251	
54.60	1,073	1,304	
54.65	1,105	1,358	
54.70	1,136	1,414	
54.75	1,168	1,472	
54.80	1,200	1,531	
54.85	1,231	1,592	
54.90	1,263	1,654	
54.95	1,294	1,718	
55.00	**1,326**	**1,784**	

Stage-Area-Storage for Pond 3P: rain garden#3 cascading

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)	
46.00	600	0	
46.05	600	12	
46.10	600	24	
46.15	600	36	
46.20	600	48	
46.25	600	60	
46.30	600	72	
46.35	600	84	
46.40	600	96	
46.45	600	108	
46.50	600	120	
46.55	600	127	
46.60	600	135	
46.65	600	142	
46.70	600	150	
46.75	600	158	
46.80	600	165	
46.85	600	173	
46.90	600	180	
46.95	600	188	
47.00	600	195	
47.05	600	202	
47.10	600	210	
47.15	600	217	
47.20	600	225	
47.25	600	233	
47.30	600	240	
47.35	600	248	
47.40	600	255	
47.45	600	263	
47.50	600	270	
47.55	600	277	
47.60	600	285	
47.65	600	292	
47.70	600	300	
47.75	600	308	
47.80	600	315	
47.85	600	322	
47.90	600	328	
47.95	600	334	
48.00	600	340	
48.05	618	370	
48.10	636	402	
48.15	654	434	
48.20	671	467	
48.25	689	501	
48.30	707	536	
48.35	725	572	
48.40	743	608	
48.45	761	646	
48.50	779	685	
48.55	796	724	
48.60	814	764	
48.65	832	805	
48.70	850	847	
48.75	868	890	
48.80	886	934	
48.85	903	979	
48.90	921	1,024	
48.95	939	1,071	
49.00	957	1,118	
49.05	978	1,167	
49.10	999	1,216	
49.15	1,019	1,267	
49.20	1,040	1,318	
49.25	1,061	1,371	
49.30	1,082	1,424	
49.35	1,103	1,479	
49.40	1,123	1,534	
49.45	1,144	1,591	
49.50	1,165	1,649	
49.55	1,186	1,708	
49.60	1,207	1,767	
49.65	1,227	1,828	
49.70	1,248	1,890	
49.75	1,269	1,953	
49.80	1,290	2,017	
49.85	1,311	2,082	
49.90	1,331	2,148	
49.95	1,352	2,215	
50.00	1,373	2,283	STATIC STORAGE
50.05	1,405	2,353	
50.10	1,437	2,424	
50.15	1,470	2,497	
50.20	1,502	2,571	
50.25	1,534	2,647	
50.30	1,566	2,724	
50.35	1,598	2,803	
50.40	1,631	2,884	
50.45	1,663	2,966	
50.50	**1,695**	**3,050**	

Stage-Area-Storage for Pond 4P: UGS-1

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
39.50	**1,672**	0	44.70	1,672	5,122
39.60	1,672	59	44.80	1,672	5,180
39.70	1,672	117	44.90	1,672	5,239
39.80	1,672	176	45.00	1,672	**5,297**
39.90	1,672	234	45.10	1,672	5,297
40.00	1,672	293	45.20	1,672	5,297
40.10	1,672	351	45.30	1,672	5,297
40.20	1,672	410	45.40	1,672	5,297
40.30	1,672	508	45.50	1,672	5,297
40.40	1,672	645	45.60	1,672	5,297
40.50	1,672	783	45.70	1,672	5,297
40.60	1,672	919	45.80	1,672	5,297
40.70	1,672	1,055	45.90	1,672	5,297
40.80	1,672	1,190	46.00	1,672	5,297
40.90	1,672	1,325	46.10	1,672	5,297
41.00	1,672	1,459	46.20	1,672	5,297
41.10	1,672	1,592	46.30	1,672	5,297
41.20	1,672	1,724	46.40	1,672	5,297
41.30	1,672	1,855	46.50	1,672	5,297
41.40	1,672	1,986	46.60	1,672	5,297
41.50	1,672	2,116	46.70	1,672	5,297
41.60	1,672	2,244	46.80	1,672	5,297
41.70	1,672	2,372	46.90	1,672	5,297
41.80	1,672	2,498	47.00	1,672	5,297
41.90	1,672	2,623	47.10	1,672	5,297
42.00	1,672	2,747	47.20	1,672	5,297
42.10	1,672	2,870	47.30	1,672	5,297
42.20	1,672	2,991	47.40	1,672	5,297
42.30	1,672	3,110	47.50	1,672	5,297
42.40	1,672	3,228	47.60	1,672	5,297
42.50	1,672	3,344			
42.60	1,672	3,458			
42.70	1,672	3,570			
42.80	1,672	3,680			
42.90	1,672	3,788			
43.00	1,672	3,893			
43.10	1,672	3,995			
43.20	1,672	4,094			
43.30	1,672	4,190			
43.40	1,672	4,282			
43.50	1,672	4,369			
43.60	1,672	4,449			
43.70	1,672	4,522			
43.80	1,672	4,588			
43.90	1,672	4,652			
44.00	1,672	4,712			
44.10	1,672	4,771			
44.20	1,672	4,829			
44.30	1,672	4,888			
44.40	1,672	4,946			
44.50	1,672	5,005			
44.60	1,672	5,063			

STATIC STORAGE

ARLINGTON HIGH SCHOOL CULVERT RELOCATION

Existing Culvert:

In the existing condition there is a large culvert, consisting of a 36″ reinforced concrete pipe (RCP), that flows under the existing building and discharges to the Mill Brook culvert. This culvert carries a large watershed from South of the project site which measures 4,626,374 sf (106.20 Ac). Historically this culvert has been shown to be undersized and has caused flooding and foloor buckling within the basement of the high school and will be relocated and improved under post construction conditions while keeping the flow rates equal to the existing flow rates so that the stormwater doesn't impact areas downstream.

Results/ Summary

Through the use of the rational method to anticpate pipe discharge rates, both the existing and proposed culvert were modeled to show flows for the 25 year storm event.

The watershed that contributes to the culvert is large and holds approximately 40.36 acres,as shown in the chart entitled WATERSHED DRAINAGE CALCULATIONS below.

WATERSHED DRAINAGE CALCULATIONS												
LOCATION		IMPERVIOUS AREA			OTHER			SUM		I	Q	
FROM	TO	A (Ac)	C	CA	A (Ac)	C	CA	CA	Tc	(in/hr)	IxCA	**DESIGN PERIOD 25-YEAR**
Watershed	Culvert	40.36	0.9	36.32	65.85	0.3	19.76	56.08	11.6	6.0	336.47	

As shown in Table 1, the post development flows are similar to the pre-development flows so that the new culvert will not have an adverse effect to downstream areas.

Existing Culvert 36" RCP															
Ex. MH	Pipe Bend	40.36	0.9	36.32	65.85	0.3	19.76	56.08	11.6	6.0	336.47	36	RCP	0.005	0.013	47.16
Pipe Bend	Ex. MH 1	40.36	0.9	36.32	65.85	0.3	19.76	56.08	11.6	6.0	336.47	36	RCP	0.160	0.013	266.79
	Site Area 1	0.47	0.9	0.42	1.07	0.3	0.32	0.74	11.6	6.0						
Ex. MH 1	Ex. MH 2	40.83	0.9	36.75	66.92	0.3	20.08	56.82	11.6	6.0	340.94	36	RCP	0.052	0.013	152.10
Ex. MH 2	Ex. MH 3	40.83	0.9	36.75	66.92	0.3	20.08	56.82	11.6	6.0	340.94	36	RCP	0.013	0.013	77.21
	Site Area 2	0.56	0.9	0.50	0.74	0.3	0.22	0.73	11.6	6.0						
Ex. MH 3	Ex. MH 4	41.39	0.9	37.25	67.66	0.3	20.30	57.55	11.6	6.0	345.29	36	RCP	0.014	0.013	78.64
	Site Area 3	0.67	0.9	0.60	0.18	0.3	0.05	0.66	11.6	6.0						
Ex. MH 4	Ex. culvert	42.06	0.9	37.85	67.84	0.3	20.35	58.21	11.6	6.0	349.24	36	RCP	0.005	0.013	47.16
Proposed Culvert - 48" / 36" CLDI Blended Option															
Ex. MH	DS-1	40.36	0.9	36.32	65.85	0.3	19.76	56.08	11.6	6.0	336.47	36	RCP	0.005	0.013	47.16
DS-1	ACC PT 1	40.36	0.9	36.32	65.85	0.3	19.76	56.08	11.6	6.0	336.47	48	DI	0.033	0.010	336.64
ACC PT 1	ACC PT 2	40.36	0.9	36.32	65.85	0.3	19.76	56.08	11.6	6.0	336.47	36	DI	0.075	0.010	237.46
ACC PT 2	ACC PT 3	40.36	0.9	36.32	65.85	0.3	19.76	56.08	11.6	6.0	336.47	36	DI	0.033	0.010	156.31
ACC PT 3	DS-2	40.36	0.9	36.32	65.85	0.3	19.76	56.08	11.6	6.0	336.47	36	DI	0.008	0.010	77.55
DS-2	Ex. culvert	40.36	0.9	36.32	65.85	0.3	19.76	56.08	11.6	6.0	336.47	36	RCP	0.005	0.013	47.16

APPENDIX 6:
Sketches

HMFH

HMFH ARCHITECTS

Samiotes Consultants Inc.

60% CONSTRUCTION DOCUMENTS
PROGRESS SET 05-04-2020

Arlington High School
Massachusetts Avenue, Arlington, Massachusetts

EXISTING CONDITIONS
HYDROLOGY MAP

REVISIONS NO.	DATE	REMARKS	BY

EX-HYD

HMFH

HMFH ARCHITECTS

samiotes

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60% CONSTRUCTION DOCUMENTS
PROGRESS SET 05-04-2020

Arlington High School
Massachusetts Avenue, Arlington, Massachusetts

PROPOSED CONDITIONS
HYDROLOGY MAP

P-HYD

HMFH

HMFH ARCHITECTS

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PROGRESS SET 05-04-2020

KEYPLAN

a b c d e

REVISIONS NO	DATE	REMARKS	BY

Arlington High School
Massachusetts Avenue, Arlington, Massachusetts

BMP LOCATION MAP

DRAWN BY: SM
CHECKED BY: SG
SCALE:

DRAWING NUMBER
BMP

JOB NUMBER 17011

Memorandum

Date:	May 27, 2020
Recipient:	HMFH Architects
Copy To:	Ms. Lori Cowles and Mr. Arthur Duffy
Sender:	William J. Burns, L.S.P. and Jonathan W. Patch, P.E.
Project:	Arlington High School
Project No:	6531.2.16
Subject:	Summary of Site Contamination Issues and Challenges Relative to Stormwater Infiltration for Conservation Commission

The former industrial and commercial use of surrounding properties has contaminated soil and groundwater across the project site. In addition, localized areas of soil have been contaminated by fuel oil that was stored in underground storage tanks (USTs) and formerly used to heat the school complex. These releases of contamination have been documented with the Massachusetts Department of Environmental Protection (DEP) under Release Tracking Numbers (RTNs) 3-4241, 3-22352, 3-22371, 3-24460 and 3-30236.

Soil and groundwater across the northern portion of the project site are contaminated by a release of metals, polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), petroleum hydrocarbons, and cyanide to which the DEP has assigned RTN 3-4241. The above referenced contaminants of concern (COCs) are primarily related to the historical operations performed by others at the adjacent Arlington Department of Public Works (DPW) facility (51 Grover Street) which included chromite ore processing activities (saw blade chroming) and manufactured gas plant (MGP) operations. The most prevalent of the COCs include chromium (trivalent and hexavalent), MGP residuals and petroleum compounds. Soil and groundwater at the southern portion of the project site is affected by a release of tetrachloroethene (PCE) to which RTN 3-30236 was assigned by the DEP. The release of PCE has migrated onto the site with the north-northeasterly direction of groundwater from a former off-site drycleaner located on the opposite side of Massachusetts Avenue.

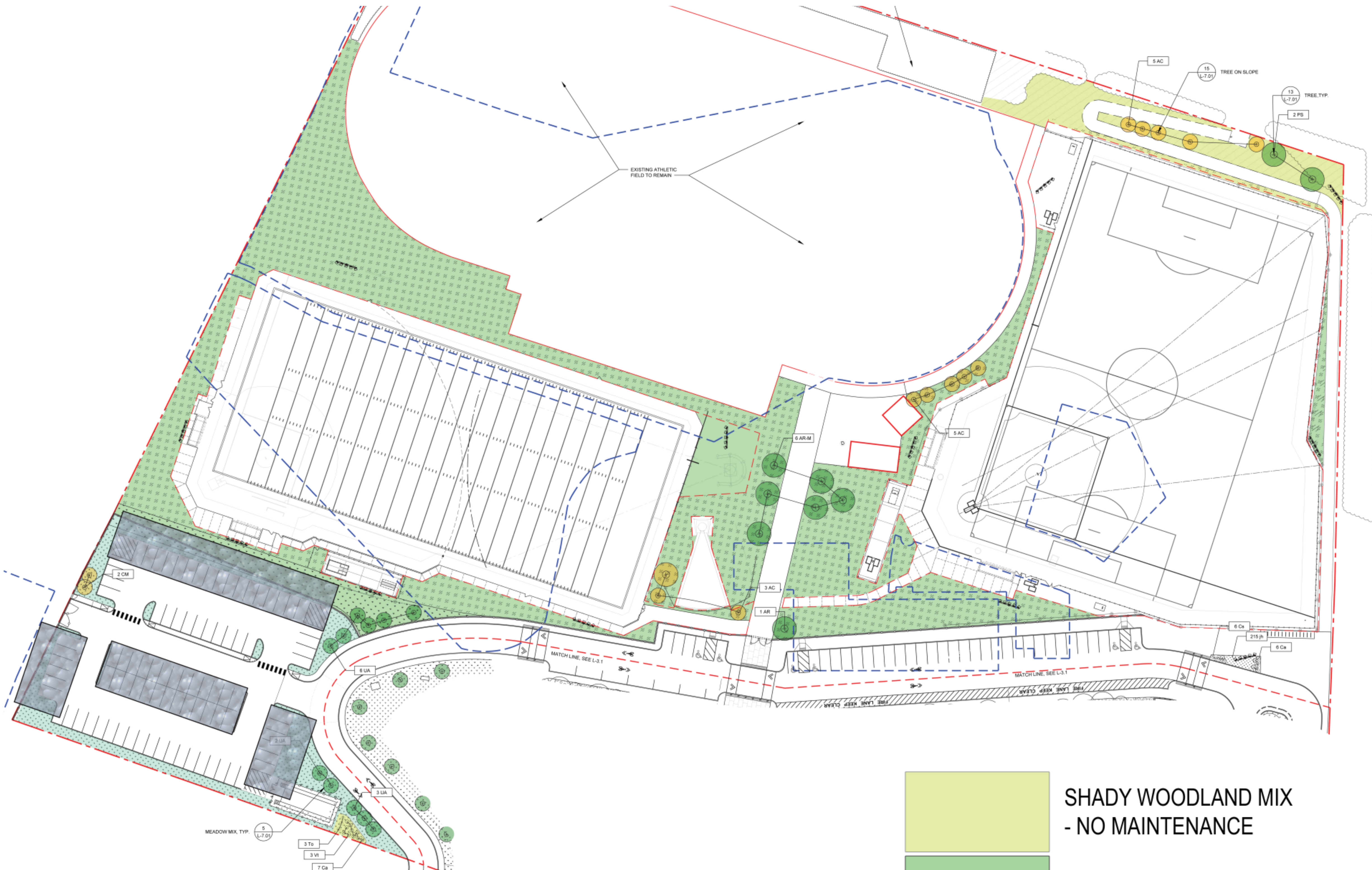
Due to the solubility and mobility of some of the COCs (in particular PCE and hexavalent chromium), infiltration of stormwater into the subsurface at many locations within the School campus may exacerbate site contamination via migration with groundwater flow. The design team has coordinated the location of the proposed infiltration systems with the Arlington Remedial Action Settlement Trust. This coordination effort has resulted in the infiltration system being located in its presently shown location to the east of the proposed building. Location of additional infiltration systems elsewhere on-site would require extensive evaluation of the leaching potential to assure that the COCs will not migrate elsewhere within the site or off-site with increased groundwater flow velocities.

N:\Working Documents\Jobs\6531 - Arlington High\McPhail Correspondence\6531_ConComEnvironmentalSummary_052720.docx
JWP/WJB

GEOTECHNICAL AND GEOENVIRONMENTAL ENGINEERS
2269 Massachusetts Avenue
Cambridge, Massachusetts 02140
(617) 868-1420

Planting Diagrams

Planting Diagrams



	SHADY WOODLAND MIX - NO MAINTENANCE
	LAWN - HEAVY MAINTENANCE WEEKLY MOWING, FERTILIZING
	MEADOW - MINIMAL MAINTENANCE CUT DOWN IN SPRING

Planting Diagrams

SHADY WOODLAND SEED MIX

by Prairie Moon Nursery®

13.28 lbs per acre | 138 Seeds per sq/ft

(PHOTOS OF PLANTS IN THIS SEED MIX)

WILDFLOWERS Botanical Name (Common Name)	% by wt.
Actaea rubra (Red Baneberry)	0.94
Agastache nepetoides (Yellow Giant Hyssop)	0.94
Ageratina altissima (White Snakeroot)	0.24
Allium tricoccum (Wild Leek)	3.67
Aquilegia canadensis (Columbine)	0.94
Aralia racemosa (Spikenard)	1.41
Arisaema triphyllum (Jack-in-the-Pulpit)	4.71
Blephilia hirsuta (Hairy Wood Mint)	0.47
Campanula americana (Tall Bellflower)	1.88
Caulophyllum thalictroides (Blue Cohosh)	3.76
Claytonia virginica (Spring Beauty)	0.47
Cryptotaenia canadensis (Honewort)	0.94
Dasistoma macrophylla (Mullein-foxglove)	0.47
Desmodium glutinosum (Pointed-leaved Tick Trefoil)	1.88
Dicentra cucullaria (Dutchman's Breeches)	0.47
Dodecatheon meadia (Midland Shooting Star)	0.47
Eurybia macrophylla (Big-leaved Aster)	0.47
Eutrochium purpureum (Sweet Joe Pye Weed)	0.47
Geranium maculatum (Wild Geranium)	1.41
Hydrophyllum appendiculatum (Great Waterleaf)	0.94
Impatiens pallida (Yellow Jewelweed)	0.47
Isopyrum biternatum (False Rue Anemone)	0.24
Lobelia inflata (Indian Tobacco)	0.71
Maianthemum racemosum (Solomon's Plume)	3.76
Mertensia virginica (Virginia Bluebells)	0.47
Mitella diphylla (Bishop's Cap)	0.47
Osmorhiza claytonii (Sweet Cicely)	2.82
Penstemon hirsutus (Hairy Beardtongue)	1.41
Phryma leptostachya (Lopseed)	0.94
Polemonium reptans (Jacob's Ladder)	2.35
Polygonatum biflorum (Solomon's Seal)	2.35
Prenanthes alba (Lion's Foot)	0.94
Rudbeckia laciniata (Wild Golden Glow)	0.47
Sanguinaria canadensis (Bloodroot)	3.53
Scrophularia marilandica (Late Figwort)	0.94
Smilax lasioneura (Common Carrion Flower)	1.41
Solidago ulmifolia (Elm-leaved Goldenrod)	0.94
Symphyotrichum lateriflorum (Calico Aster)	0.47
Symphyotrichum shortii (Short's Aster)	0.94
Taenidia integerrima (Yellow Pimpernel)	1.41
Thalictrum dioicum (Early Meadow Rue)	2.82
Triosteum perfoliatum (Late Horse Gentian)	2.35
Uvularia grandiflora (Bellwort)	1.41
Total of WILDFLOWERS:	**60.71 %**

GRASSES, SEDGES & RUSHES Botanical Name (Common Name)	% by wt.
Bromus latiglumis (Ear-leaved Brome)	1.88
Carex grayi (Common Bur Sedge)	0.71
Carex grisea (Wood Gray Sedge)	1.41
Carex sprengelii (Long-beaked Sedge)	0.94
Cinna arundinacea (Wood Reed Grass)	0.47
Diarrhena obovata (Beak Grass)	5.18
Elymus hystrix (Bottlebrush Grass)	5.65
Elymus riparius (Riverbank Wild Rye)	1.88
Elymus villosus (Silky Wild Rye)	3.76
Elymus virginicus (Virginia Wild Rye)	15.06
Festuca subverticillata (Nodding Fescue)	1.88
Glyceria striata (Fowl Manna Grass)	0.47
Totals of GRASSES, SEDGES & RUSHES:	**39.29 %**

(PHOTOS OF PLANTS IN THIS SEED MIX)

Last updated 1/22/2020

Woodland Slope Planting

Planting Diagrams





Wetland Planting

DETENTION BASIN SEED MIX

by Prairie Moon Nursery®

9.44 lbs per acre | 307 Seeds per sq/ft

(PHOTOS OF PLANTS IN THIS SEED MIX)

WILDFLOWERS

Botanical Name (Common Name)	% by wt.
Alisma subcordatum (Mud Plantain)	1.32
Allium stellatum (Prairie Onion)	0.99
Ammannia coccinea (Scarlet Toothcup)	0.99
Anemone canadensis (Canada Anemone)	0.66
Angelica atropurpurea (Angelica)	3.97
Asclepias incarnata (Rose Milkweed)	2.65
Astragalus canadensis (Canada Milk Vetch)	0.66
Bidens cernua (Nodding Bur Marigold)	0.66
Boltonia asteroides (False Aster)	0.66
Eupatorium perfoliatum (Boneset)	0.50
Eupatorium maculatum (Joe Pye Weed)	0.66
Gentiana andrewsii (Bottle Gentian)	0.36
Gentiana flavida (Cream Gentian)	0.36
Helenium autumnale (Sneezeweed)	0.72
Heliopsis helianthoides (Early Sunflower)	1.32
Hibiscus laevis (Rose Mallow)	3.97
Hypericum pyramidatum (Great St. John's Wort)	0.66
Iris versicolor (Northern Blue Flag)	2.65
Liatris pycnostachya (Prairie Blazing Star)	3.31
Lobelia cardinalis (Cardinal Flower)	0.33
Lobelia siphilitica (Great Blue Lobelia)	1.32
Mimulus ringens (Monkey Flower)	0.33
Oligoneuron rigidum (Stiff Goldenrod)	0.66
Pedicularis lanceolata (Marsh Betony)	0.66
Persicaria punctata (Smartweed)	0.99
Physostegia virginiana (Obedient Plant)	0.72
Pycnanthemum virginianum (Mountain Mint)	0.66
Rudbeckia hirta (Black-eyed Susan)	1.99
Rudbeckia subtomentosa (Sweet Black-eyed Susan)	0.36
Rudbeckia triloba (Brown-eyed Susan)	1.32
Silphium laciniatum (Compass Plant)	0.66
Silphium perfoliatum (Cup Plant)	0.66
Veronicastrum virginicum (Culver's Root)	0.66
Zizia aurea (Golden Alexanders)	1.32
Totals of WILDFLOWERS:	**46.37 %**

GRASSES, SEDGES & RUSHES

Botanical Name (Common Name)	% by wt.
Andropogon gerardii (Big Bluestem)	6.62
Bromus ciliatus (Fringed Brome)	5.19
Calamagrostis canadensis (Blue Joint Grass)	0.35
Carex bicknellii (Copper-shouldered Oval Sedge)	1.32
Carex hystericina (Porcupine Sedge)	1.32
Carex stipata (Awl-fruited Sedge)	1.32
Carex vulpinoidea (Brown Fox Sedge)	3.31
Elymus canadensis (Canada Wild Rye)	10.59
Elymus virginicus (Virginia Wild Rye)	10.59
Glyceria grandis (Reed Manna Grass)	1.32
Juncus dudleyi (Dudley's Rush)	0.33
Juncus interior (Inland Rush)	0.29
Panicum virgatum (Switch Grass)	1.32
Scirpus atrovirens (Dark-green Bulrush)	0.72
Scirpus cyperinus (Wool Grass)	0.37
Scirpus validus (Great Bulrush)	0.72
Sorghastrum nutans (Indian Grass)	6.62
Spartina pectinata (Cord Grass)	1.32
Totals of GRASSES, SEDGES & RUSHES:	**53.63 %**

(PHOTOS OF PLANTS IN THIS SEED MIX)

Last updated 1/7/20

Planting Diagrams




Meadow Planting

PRETTY DARN QUICK (PDQ)© SEED MIX

by Prairie Moon Nursery®

11.16 lbs per acre | 190 Seeds per sq/ft

(PHOTOS OF PLANTS IN THIS SEED MIX)

WILDFLOWERS	
Botanical Name (Common Name)	**% by wt.**
Agastache foeniculum (Anise Hyssop)	0.56
Allium stellatum (Prairie Onion)	1.12
Asclepias incarnata (Rose Milkweed)	1.12
Astragalus canadensis (Canada Milk Vetch)	0.28
Bidens aristosa (Swamp Marigold)	0.56
Chamaecrista fasciculata (Partridge Pea)	17.93
Coreopsis lanceolata (Lance-leaf Coreopsis)	2.80
Crotalaria sagittalis (Rattlebox)	4.48
Dalea candida (White Prairie Clover)	1.68
Drymocallis arguta (Prairie Cinquefoil)	0.56
Echinacea purpurea (Purple Coneflower)	3.36
Eryngium yuccifolium (Rattlesnake Master)	1.12
Gentianella quinquefolia (Stiff Gentian)	0.28
Helenium autumnale (Sneezeweed)	0.56
Lobelia siphilitica (Great Blue Lobelia)	1.12
Monarda fistulosa (Wild Bergamot)	0.56
Oligoneuron rigidum (Stiff Goldenrod)	0.56
Penstemon digitalis (Foxglove Beardtongue)	1.12
Pycnanthemum virginianum (Mountain Mint)	0.56
Ratibida pinnata (Yellow Coneflower)	0.56
Rudbeckia hirta (Black-eyed Susan)	6.72
Rudbeckia triloba (Brown-eyed Susan)	0.28
Symphyotrichum laeve (Smooth Blue Aster)	1.12
Verbena hastata (Blue Vervain)	1.12
Verbena stricta (Hoary Vervain)	0.56
Zizia aurea (Golden Alexanders)	2.24
Total of WILDFLOWERS:	**55.74 %**

GRASSES, SEDGES & RUSHES	
Botanical Name (Common Name)	**% by wt.**
Bouteloua curtipendula (Side-oats Grama)	17.93
Carex brevior (Plains Oval Sedge)	2.24
Carex vulpinoidea (Brown Fox Sedge)	1.12
Elymus canadensis (Canada Wild Rye)	8.96
Juncus dudleyi (Dudley's Rush)	0.56
Schyzachyrium scoparium (Little Bluestem)	13.45
Totals of GRASSES, SEDGES & RUSHES:	**44.26 %**

(PHOTOS OF PLANTS IN THIS SEED MIX)

Last updated 2/6/2020

ARLINGTON HIGH SCHOOL
RAIN GARDEN DESIGN NARRATIVE

Introduction

This narrative is provided at the request of the Arlington Conservation Commission to clearly explain the design intent and value of the proposed Rain Gardens as part of the stormwater management system for the proposed Arlington High School construction project. As these rain gardens are not able to infiltrate into the underlying soils due to issues with ground contamination in the areas proposed, this narrative seeks to explain how the system will function to provide a valuable improvement to the water quality treatment of the surrounding area. This also promotes climate change resiliency per the Arlington bylaws.

Rain Garden Definition

The following language is provided from the Massachusetts Stormwater Handbook (Volume 2; Chapter 2; Page 23) which defines Rain Gardens and Bioretention Areas. The two terms bioretention area and rain garden are synonymous, and the type of system proposed has been bolded in the passage below:

"Bioretention is a technique that uses soils, plants, and microbes to treat stormwater before it is infiltrated and/or discharged. Bioretention cells are shallow depressions filled with sandy soil topped with a thick layer of mulch and planted with dense native vegetation. Stormwater runoff is directed into the cell via piped or sheet flow. The runoff percolates through the soil media that acts as a filter. There are two types of bioretention cells: **those that are designated solely as an organic filter filtering bioretention areas** and those configured to recharge groundwater in addition to acting as a filter exfiltrating bioretention areas**. A filtering bioretention area includes an impermeable liner and underdrain that intercepts the runoff before it reaches the water table so that it may be conveyed to a discharge outlet, other best management practices or the municipal storm drain system.**"

Benefits of Rain Gardens

Rain gardens are very valuable stormwater Best Management Practices (BMPs) because of the water quality treatment that they provide. The Massachusetts Stormwater Management Handbook specifies that Rain Gardens (whether exfiltrating into the ground or lined) provide 90% Total Suspended Solids Removal (TSS) with adequate pretreatment. We provide pretreatment via deep sump catch basins for all flows to the proposed Rain Garden system. This makes Rain Garden a very desireable BMP to use wherever space allows. For example, an infiltration basin only receives 80% TSS removal, 10% less than the Rain Garden equivalent.

Unlike typical infiltration systems, Rain Gardens also provide pollutant removal beyond suspended solids. Per the Massachusetts Stormwater Handbook, Rain Gardens remov 30-50% of total nitrogen load to the system, 30-90% total phosphorus, and 40-90% of other metals such as copper, lead, zinc, and cadmium. This is a great addition to an already robust design to increase the water quality of the flows from the proposed stormwater system associated with the Arlington High School project. As mentioned previously, the rain gardens also promote climate change resiliency and evapotranspiration.

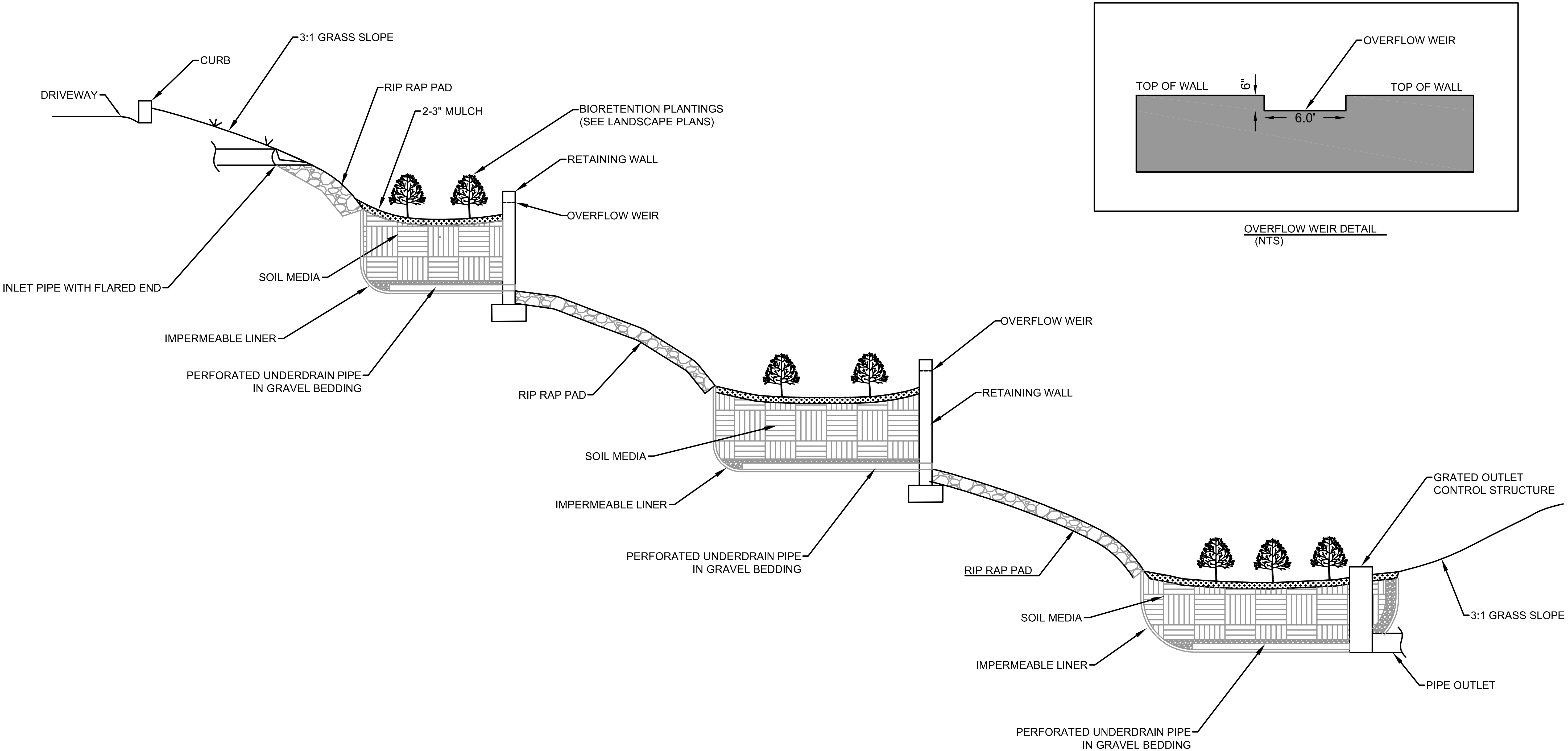
Rain Garden System Design

Rain Gardens are intended to hold a small amount of stormwater for filtration, with an overflow provided for larger stormwater events where the storage of the garden is exceeded by the inflow of stormwater. The filter is provided via a series of layers of natural material, with an underdrain provided at the bottom of a lined Rain Garden system to convey the filtered stormwater to the stormwater management system. The filter consists of two (2) to three (3) inches of mulch on the ground surface with plantings, with between two (2) and four (4) feet of planting soil underneath. The bottom layer consists of eight (8) inches of gravel across the footprint of the Rain Garden which also acts as the bedding for the underdrain. For a lined system such as the one designed for this project, the liner will wrap the entire filter area on the bottom and sides to prevent exfiltration of stormwater into the ground. The mulch and soil specifications are provided within the Massachusetts Stormwater Handbook, and are contained within the project specifications to ensure that the requirements for the system per the handbook are met.

Plantings proposed within the Rain Gardens are those defined in the “Plant Species Suitable For Use in Bioretention – Herbaceous Species” list within the Massachusetts Stormwater Handbook. The plantings chosen, shown on the landscape plans for the project, are all native species. A list of the plantings used, highlighted from the list in the Massachusetts Stormwater Handbook is appended to this narrative.

Stormwater Routing

The Rain Garden system design for the Arlington High School project consists of a series of three (3) cascading Rain Gardens separated by retaining walls moving down the slope on the west side of the proposed building as shown on the Stormwater Management Plans. Per the definition provided above, these Rain Gardens are each lined with impermeable liner to prevent exfiltration of stormwater into the ground which is not suitable for infiltration. An underdrain pipe is provided for each Rain Garden to convey flows after they have filtered through the mulch and soil media. These underdrain pipes for RG-1 and RG-2 discharge to the Rain Garden downstream (RG-2 and RG-3 respectively). The top two Rain Gardens (RG-1 and RG-2) have a weir wall on their north side. This is intended to allow stormwater flows to travel over the portion of the wall adjacent to the Rain Garden in larger storm events to prevent overflow of the system. Stormwater flowing over the weir wall is intended to drop onto the rip rap pad below in the Rain Garden directly downstream of RG-1 and RG-2 (RG-2 and RG-3 respectively). RG-3 includes an outlet control structure with a series of orifices to allow for stormwater to discharge from the Rain Garden when the storage provided is exceeded without overflowing into the surrounding areas in addition to the underdrain piping for the filtered water. See the attached sketch plan for reference on the location of the various elements of the Rain Garden system graphically as described above.



OVERFLOW WEIR DETAIL
(NTS)

Sketch No.	SKCE-A
Reference Drawing	-
Job #:	17211.00
Drawn by:	SM
Scale:	NTS
Date:	5/28/20
Project:	ARLINGTON HIGH SCHOOL
Title:	RAIN GARDEN SKETCH

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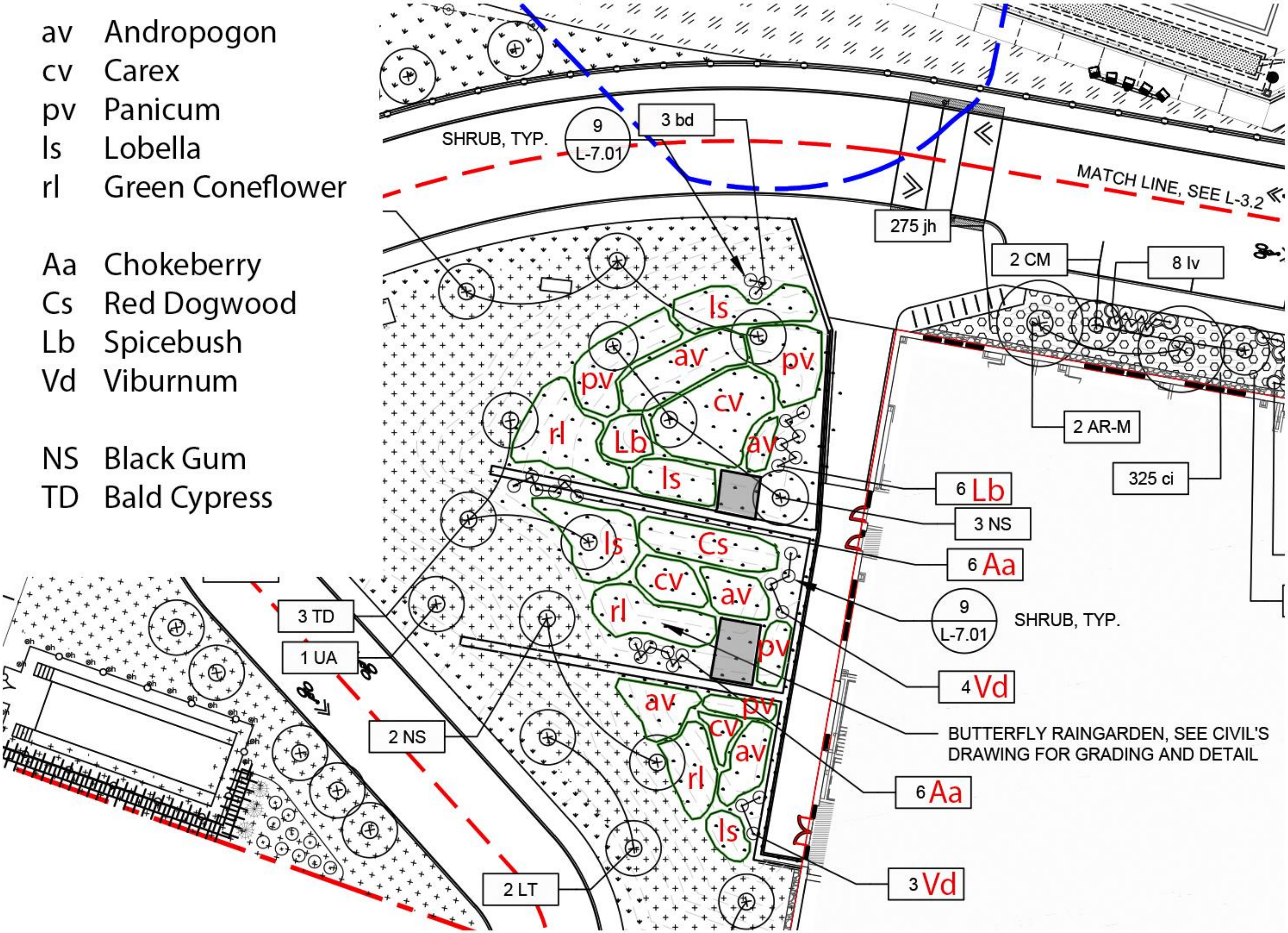
av Andropogon
cv Carex
pv Panicum
ls Lobella
rl Green Coneflower

Aa Chokeberry
Cs Red Dogwood
Lb Spicebush
Vd Viburnum

NS Black Gum
TD Bald Cypress



ARLINGTON HIGH SCHOOL
Arlington, MA

RAIN GARDEN PLANTING SKETCH

Crosby | Schlessinger | Smallridge
CSS
Landscape Architecture | Planning | Urban Design

Plant Species Suitable for Use in Bioretention - Herbaceous Species

Species	Moisture Regime		Tolerance						Morphology			General Characteristics		Comments
Scientific Name **Common Name**	**Indicator Status**	**Habitat**	**Ponding (days)**	**Salt**	**Oil/ Grease**	**Metals**	**Insects/ Disease**	**Exposure**	**Form**	**Height**	**Root System**	**Native**	**Wildlife**	
Agrostis alba redtop	FAC	Mesic-Xeric	1-2	H	–	H	H	Shade	Grass	2-3'	Fiberous Shallow	Yes	High	–
Andropogon gerardi bluejoint	FAC	Dry Mesic-Mesic	1-2	–	–	–	–	Sun	Grass	2-3'	Fiberous Shallow	Yes	High	–
Andropogon virginicus broomsedge	–	Wet meadow	1-2	L	–			Full sun	Grass	1-3'		Yes	High	Tolerant of fluctuating water levels and drought.
Carex vulpinoidea fox sedge	OBL	Freshwater marsh	2-4	L	–			Sun to partial sun	Grass	2-3.5'	Rhizome	Yes	High	–
Chelone glabra														
Deschampsia caespitosa tufted hairgrass	FACW	Mesic to wet Mesic	2-4	H	–	H	H	Sun	Grass	2-3'	Fiberous Shallow	Yes	High	May become invasive.
Glyceria striata fowl mannagrass, nerved mannagrass	OBL	Freshwater marsh, seeps	1-2	L	–			Partial shade to full shade	Grass	2-4'	Rhizome	Yes	High	–
Hedera helix English Ivy	FACU	Mesic	1-2	–	–	–	H	Sun	Evergreen ground cover	–	Fiberous Shallow	No	Low	–
Hibiscus palustris														
Iris kaempferi														

H High Tolerance
M Medium Tolerance
L Low Tolerance

FACU Facultative Upland - Usually occur in non-wetlands, however, occasionally found in wetlands.
FAC Facultative - Equally likely to occur in wetlands and non-wetlands.
FACW Facultative Wetland - Usually occur in wetlands, however, occasionally found in non-wetlands.
OBL Obligate Wetland - Occur almost always in wetlands

Adapted from the Prince George's County Design Manual & the Center for Watershed Protection for the use of bioretention in Stormwater Management

Plant Species Suitable for Use in Bioretention - Herbaceous Species

Species	Moisture Regime		Tolerance						Morphology			General Characteristics		Comments
Scientific Name Common Name	Indicator Status	Habitat	Ponding (days)	Salt	Oil/ Grease	Metals	Insects/ Disease	Exposure	Form	Height	Root System	Native	Wildlife	
Lobelia siphilitica														
Lotus Corniculatus birdsfoot-trefoil	FAC	Mesic-Xeric	1-2	H	L	H	H	Sun	Grass	2-3'	Fiberous Shallow	Yes	High	Member of the legume family.
Onoclea sensibilis sensitive fern, beadfern	FACW							Shade		1-3.5'			H	
Pachysandra terminalis Japanese pachysandra	FACU	Mesic	1-2	-	-	-	M	Shade	Evergreen ground cover	-	Fiberous Shallow	No	Low	-
Panicum virgatum switch grass	FAC to FACU	Mesic	2-4	H	-	-	H	Sun or Shade	Grass	4-5'	Fiberous Shallow	Yes	High	Can spread fast and reach height of 6'.
Vinca major large periwinkle	FACU	Mesic	1-2	-	-	-	H	Shade	Evergreen ground cover	-	Fiberous Shallow	No	Low	Sensitive to soil compaction and pH changes.
Vinca minor common periwinkle	FACU	Mesic	1-2	-	-	-	H	Shade	Evergreen ground cover	-	Fiberous Shallow	No	Low	-
Indian grass														
Little bluestem														
Deer tongue														
Green coneflower														

H High Tolerance
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L Low Tolerance

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FAC Facultative - Equally likely to occur in wetlands and non-wetlands.
FACW Facultative Wetland - Usually occur in wetlands, however, occasionally found in non-wetlands.
OBL Obligate Wetland - Occur almost always in wetlands

Adapted from the Prince George's County Design Manual & the Center for Watershed Protection for the use of bioretention in Stormwater Management

Plant Species Suitable for Use in Bioretention - Herbaceous Species

Species	Moisture Regime		Tolerance						Morphology			General Characteristics		Comments
Scientific Name Common Name	Indicator Status	Habitat	Ponding (days)	Salt	Oil/ Grease	Metals	Insects/ Disease	Exposure	Form	Height	Root System	Native	Wildlife	
Aronia arbutifolia (*Pyrus arbutifolia*) red chokeberry	FACW	Mesic	1-2	H	–	H	M	Sun to partial sun	Deciduous shrub	6-12'	–	Yes	High	Good bank stabilizer. Tolerates drought.
Clethra alnifolia sweet pepperbush	FAC	Mesic to wet Mesic	2-4	H	–	–	H	Sun to partial sun	Ovoid shrub	6-12'	Shallow	Yes	Med	Coastal plain species.
Cornus Stolonifera (*Cornus sericea*) red osier dogwood	FACW	Mesic-Hydric	2-4	H	H	H	M	Sun or shade	Arching, spreading shrub	8-10'	Shallow	Yes	High	Needs more consistent moisture levels.
Cornus amomum silky dogwood	FAC	Mesic	1-2	L	–	–	M	Sun to partial sun	Broad-leaved	6-12'	–	Yes	High	Good bank stabilizer
Euonymous europaeus spindle-tree	FAC	Mesic	1-2	M	M	M	M	Sun to partial sun	Upright dense oval shrub	10-12'	Shallow	No	No	–
Hamamelis virginiana witch hazel	FAC	Mesic	2-4	M	M	M	M	Sun or shade	Vase-like compact shrub	4-6'	Shallow	Yes	Low	–
Hypericum densiflorum common St. John's wort	FAC	Mesic	2-4	H	M	M	H	Sun	Ovoid shrub	3-6'	Shallow	Yes	Med	–
Ilex glabra inkberry	FACW	Mesic to wet Mesic	2-4	H	H	–	H	Sun to partial sun	Upright dense shrub	6-12'	Shallow	Yes	High	Coastal plain species.
Ilex verticillata winterberry	FACW	Mesic to wet Mesic	2-4	L	M	–	H	Sun to partial sun	Spreading shrub	6-12'	Shallow	Yes	High	–

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Scientific Name **Common Name**	**Indicator Status**	**Habitat**	**Ponding (days)**	**Salt**	**Oil/ Grease**	**Metals**	**Insects/ Disease**	**Exposure**	**Form**	**Height**	**Root System**	**Native**	**Wildlife**	
Itea virginica tassel-white, Virginia sweetspire	OBL	Mesic	1-2	M	–	–	M	Sun or shade	Broad-leaved, deciduous shrub	6-12'	–	Yes	Low	–
Juniperus communis "compressa" common juniper	FAC	Dry Mesic-Mesic	1-2	M	H	H	M-H	Sun	Mounded shrub	3-6'	Deep taproot	No	High	Evergreen
Juniperus horizontalis 'Bar Harbor' *creeping juniper*	FAC	Dry Mesic-Mesic	1-2	M	H	H	M-H	Sun	Matted shrub	0-3'	Deep taproot	No	High	Evergreen
Lindera benzoin spicebush	FACW	Mesic to wet Mesic	2-4	H	–	–	H	Sun	Upright shrub	6-12'	Deep	Yes	High	–
Myrica pennsylvanica bayberry	FAC	Mesic	2-4	H	M	M	H	Sun to partial sun	Rounded, compact shrub	6-8'	Shallow	Yes	High	Coastal plain species.
Physocarpus opulifolius ninebark	FAC	Dry Mesic to wet Mesic	2-4	M	–	–	H	Sun	Upright shrub	6-12'	Shallow	Yes	Med	May be difficult to locate.
Viburnum cassinoides northern wild raisin	FACW	Mesic	2-4	H	H	H	H	Sun to partial sun	Rounded, compacted shrub	6-8'	Shallow	Yes	High	–
Viburnum dentatum arrow-wood	FAC	Mesic to wet	2-4	H	H	H	H	Sun to partial sun	Upright, multi-stemmed shrub	8-10'	Shallow	Yes	High	–
Viburnum lentago nannyberry	FAC	Mesic	2-4	H	H	H	H	Sun to partial sun	Upright, mlti-stemmed shrub	8-10'	Shallow	Yes	High	–

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Scientific Name Common Name	Indicator Status	Habitat	Ponding (days)	Salt	Oil/ Grease	Metals	Insects/ Disease	Exposure	Form	Height	Root System	Native	Wildlife	
Acer rubrum red maple	FAC	Mesic-Hydric	4-6	H	H	H	H	Partial sun	Single to multi-stem tree	50-70'	Shallow	Yes	High	-
Amelanchier canadensis shadbush	FAC	Mesic	2-4	H	M	-	H	Partial sun	Single to multi-stem tree	35-50'	Shallow	Yes	High	Not recommended for full sun.
Betula nigra river birch	FACW	Mesic-Hydric	4-6	-	M	M	H	Partial sun	Single to multi-stem tree	50-75'	Shallow	Yes	High	Not susceptible to bronze birch borer.
Betula populifolia gray birch	FAC	Xeric-Hydric	4-6	H	H	M	H	Partial sun	Single to multi-stem tree	35-50'	Shallow to deep	No	High	Native to New England area.
Fraxinus americana white ash	FAC	Mesic	2-4	M	H	H	H	Sun	Large tree	50-80'	Deep	Yes	Low	-
Fraxinus Pennsylvanica green ash	FACW	Mesic	4-6	M	H	H	H	Partial sun	Large tree	40-65'	Shallow to deep	Yes	Low	-
Ginko biloba Maidenhair tree	FAC	Mesic	2-4	H	H	H	H	Sun	Large tree	50-80'	Shallow to deep	No	Low	Avoid female species-offensive odor from fruit.
Gleditsia triacanthos honeylocust	FAC	Mesic	2-4	H	M	-	M	Sun	Small caopled large tree	50-75'	Shallow to deep variable taproot	Yes	Low	Select thornless variety.
Juniperus virginiana eastern red cedar	FACU	Mesic-Xeric	2-4	H	H	-	H	Sun	Dense single stem tree	50-75'	Taproot	Yes	Very high	Evergreen
Liquidambar styraciflua sweet gum	FAC	Mesic	4-6	H	H	H	M	Sun	Large tree	50-70'	Deep taproot	Yes	High	Edge and perimeter; fruit is a maintenance problem.
Nyssa sylvatica black gum	FACW	Mesic-Hydric	4-6	H	H	H	H	Sun	Large tree	40-70'	Shallow to deep taproot	Yes	High	-

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Scientific Name **Common Name**	**Indicator Status**	**Habitat**	**Ponding (days)**	**Salt**	**Oil/ Grease**	**Metals**	**Insects/ Disease**	**Exposure**	**Form**	**Height**	**Root System**	**Native**	**Wildlife**	
Platanus acerifolia London plane-tree	FACW	Mesic	2-4	H	–	–	M	Sun	Large tree	70-80'	Shallow	No	Low	Tree roots can heave sidewalks.
Platanus occidentalis sycamore	FACW	Mesic-Hydric	4-6	M	M	M	M	Sun	Large tree	70-80'	Shallow	Yes	Med	Edge and perimeter; fruit is a maintennance problem; tree is also prone to windthrow.
Populus deltoides eastern cottonnwood	FAC	Xeric-Mesic	4-6	H	H	H	L	Sun	Large tree with spreading branches	75-100'	Shallow	Yes	High	Short lived.
Quercus bicolor Swamp white oak	FACW	Mesic to wet Mesic	4-6	H	–	H	H	Sun to partial sun	Large tree	75-100'	Shallow	Yes	High	One of the faster growing oaks.
Quercus coccinea scarlet oak	FAC	Mesic	1-2	H	M	M	M	Sun	Large tree	50-75'	Shallow to deep	Yes	High	–
Quercus macrocarpa bur oak	FAC	Mesic to wet Mesic	2-4	H	H	H	M	Sun	Large spreading tree	75-100"	Taproot	No	High	Native to Midwest.
Quercus palustris pin oak	FACW	Mesic-Hydric	4-6	H	H	H	M	Sun	Large tree	60-80'	Shallow to deep taproot	Yes	High	–
Quercus phellos willow oak	FACW	Mesic to wet Mesic	4-6	H	–	–	H	Sun	Large tree	55-75'	Shallow	Yes	High	Fast growing oak.
Quercus rubra red oak	FAC	Mesic	2-4	M	H	M	M	Sun to partial sun	Large spreading tree	60-80'	Deep taproot	Yes	High	–
Quercus shumardii Shumard's red oak	FAC	Mesic	2-4	H	H	H	M	Sun to partial sun	Large spreading tree	60-80'	Deep taproot	No	High	Native to Southeast.

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Species	Moisture Regime		Tolerance						Morphology			General Characteristics		Comments
Scientific Name **Common Name**	**Indicator Status**	**Habitat**	**Ponding (days)**	**Salt**	**Oil/ Grease**	**Metals**	**Insects/ Disease**	**Exposure**	**Form**	**Height**	**Root System**	**Native**	**Wildlife**	
Sophora japonica Japanese pagoda tree	FAC	Mesic	1-2	M	M	_	M	Sun	Shade tree	40-70'	Shallow	No	Low	Fruit stains sidewalk.
Taxodium distichum bald cypress	FACW	Mesic-Hydric	4-6	–	–	M	H	Sun to partial sun	Typically single stem tree	75-100'	Shallow	Yes	Low	Not well documented for planting in urban areas.
Thuja occidentalis arborvitae	FACW	Mesic to wet Mesic	2-4	M	M	M	H	Sun to partial sun	Dense single stem tree	50-75'	Shallow	No	Low	Evergreen
Zelkova serrata Japanese zelkova	FACU	Mesic	1-2	M	M	_	H	Sun	Dense shade tree	60-70'	Shallow	No	Low	Branches can split easily in storms.

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Conservation Commission Requests for Information #3

Re: Arlington High School Expansion SCI File #17211.00

RE: Conservation Requests May 21,2020 Item #3 Riverfront Analysis

310CMR 10.58.5
(5) Redevelopment Within Previously Developed Riverfront Areas; Restoration and Mitigation. Notwithstanding the provisions of 310 CMR 10.58(4)(c) and (d), the issuing authority may allow work to redevelop a previously developed riverfront area, provided the proposed work improves existing conditions. Redevelopment means replacement, rehabilitation or expansion of existing structures, improvement of existing roads, or reuse of degraded or previously developed areas. A previously developed riverfront area contains areas degraded prior to August 7, 1996 by impervious surfaces from existing structures or pavement, absence of topsoil, junkyards, or abandoned dumping grounds. Work to redevelop previously developed riverfront areas shall conform to the following criteria:

(a) At a minimum, proposed work shall result in an improvement over existing conditions of the capacity of the riverfront area to protect the interests identified in M.G.L. c. 131 § 40. When a lot is previously developed but no portion of the riverfront area is degraded, the requirements of 310 CMR 10.58(4) shall be met.

Response: The proposed riverfront area on the east side of the site is currently a paved parking lot with degraded landscaped islands, which lacks topsoil and its surface is compacted gravel from vehicle traffic. Previously disturbed areas behind the existing curb to the top of bank of the Mill Brook consists of low vegetation and poison ivy. A single existing catch basin conveys stormwater run-off from this section of parking to Mill Brook.

Under the proposed conditions, this area will be replaced with a new paved parking lot with vertical granite curbed islands that will be planted with native trees and grasses. The area behind the curb to the top of bank will be selectively cleared and re-planted. Stormwater from the parking lot will sheet flow to a new water quality inlet that will treat the stormwater to current standards before being released into Mill Brook.

Therefore 10.58.5 (a) is met.

(b) Stormwater management is provided according to standards established by the Department.

Response: Stormwater controls have been established in accordance to the DEP Stormwater Standards.

Therefore 10.58.5 (b) is met.

(c) Within 200 foot riverfront areas, proposed work shall not be located closer to the river than existing conditions or 100 feet, whichever is less, or not closer than existing conditions within 25 foot riverfront areas, except in accordance with 310 CMR 10.58(5) (f) or (g).

Response: Under existing conditions the back of curb is approximately 7.5′ from the top of bank. Under proposed conditions the curb will be moved back to measure approximately 15′ from the top of bank.

Therefore 10.58.5 (c) is met.

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(d) Proposed work, including expansion of existing structures, shall be located outside the riverfront area or toward the riverfront area boundary and away from the river, except in accordance with 310 CMR 10.58(5)(f) or (g).

Response: Under the proposed conditions the new curb will be moved back 7.5' from the top of bank. Under the proposed conditions, the impervious area will be equal to the existing impervious but will be improved.

Therefore 10.58.5 (d) is met. See response for 10.58.5 (f)(g)

(e) The area of proposed work shall not exceed the amount of degraded area, provided that the proposed work may alter up to 10% if the degraded area is less than 10% of the riverfront area, except in accordance with 310 CMR 10.58(5)(f) or (g).

Response: Under proposed conditions the proposed work will alter approximately 7% of the riverfront area and improve much of the existing degraded areas.

Therefore 10.58.5 (e) is met. See response for 10.58.5 (f)(g)

*(f) When an applicant proposes restoration on-site of degraded riverfront area, alteration may be allowed notwithstanding the criteria of 310 CMR 10.58(5)(c), (d), and (e) at a ratio in square feet of at least 1:1 of restored area to area of alteration not conforming to the criteria. Areas immediately along the river shall be selected for restoration. Alteration not conforming to the criteria shall begin at the riverfront area boundary. Restoration shall include:**1.** removal of all debris, but retaining any trees or other mature vegetation;**2.** grading to a topography which reduces runoff and increases infiltration;**3.** coverage by topsoil at a depth consistent with natural conditions at the site; and**4.** seeding and planting with an erosion control seed mixture, followed by plantings of herbaceous and woody species appropriate to the site;*

Response: All restoration will conform to items 1-4 above.

Therefore 10.58.5 (f) is met. See response for 10.58.5 (d)(e)(g)

(g) When an applicant proposes mitigation either on-site or in the riverfront area within the same general area of the river basin, alteration may be allowed notwithstanding the criteria of 310 CMR 10.58(5)(c), (d), or (e) at a ratio in square feet of at least 2:1 of mitigation area to area of alteration not conforming to the criteria or an equivalent level of environmental protection where square footage is not a relevant measure. Alteration not conforming to the criteria shall begin at the riverfront area boundary. Mitigation may include off-site restoration of riverfront areas, conservation restrictions under M.G.L. c. 184, §§ 31 through 33 to preserve undisturbed riverfront areas that could be otherwise altered under 310 CMR 10.00, the purchase of development rights within the riverfront area, the restoration of bordering vegetated wetland, projects to remedy an existing adverse impact on the interests identified in M.G.L. c. 131, § 40 for which the applicant is not legally responsible, or similar activities undertaken voluntarily by the applicant which will support a determination by the issuing authority of no significant adverse impact. Preference shall be given to potential mitigation projects, if any, identified in a River Basin Plan approved by the Secretary of the Executive Office of Energy and Environmental Affairs.

Response: The project is not proposing any mitigation on-site just restoration of the Riverfront area as detailed in 10.58.5 (f) response.

Therefore 10.58.5 (g) is met. See response for 10.58.5 (d)(e)(f)

(h) The issuing authority shall include a continuing condition in the Certificate of Compliance for projects under 310 CMR 10.58(5)(f) or (g) prohibiting further alteration within the restoration or mitigation area, except as may be required to maintain the area in its restored or mitigated condition. Prior to requesting the issuance of the Certificate of Compliance, the applicant shall demonstrate the restoration or mitigation has been successfully completed for at least two growing seasons.

Response: The applicant understands the qualifications 10.58.5 (h)

Conservation Commission Requests for Information #4

Re: Arlington High School Expansion SCI File #17211.00

RE: Conservation Requests May 21, 2020 Item #4 AURA Analysis

Section 25 – Adjacent Upland Resource Area

C. Alternatives to Work in Adjacent Upland Resource Area. A growing body of research evidence suggests that even "no disturbance" areas reaching beyond 25 feet from wetlands, streams, rivers, and other water bodies may be insufficient to protect many important characteristics and values. Problems of nutrient runoff, water pollution, siltation, erosion, vegetation change, and habitat destruction are greatly exacerbated by activities within 100 feet of wetlands. Thus, work and activity in the Adjacent Upland Resource Area shall be avoided and discouraged and reasonable alternatives pursued.

Only when the Applicant proves through a written alternative analysis that reasonable alternatives are not available or practicable, the Commission may, in its discretion, allow temporary, limited, or permanent disturbance as appropriate and consistent with this Section depending on the characteristics of the Adjacent Upland Resource Area, including but not limited to the following:

(1) slope

- *The proposed design provides a stabilized slope planted with native plants and grasses.*

(2) soil characteristics

- *The soils horizon is "B" type soils but the surface is degraded with areas of distressed pavement, islands that have been used as parking and are compacted gravel and slopes that have little to no topsoil left on them to properly grow groundcover to stabilize the slope.*

(3) drainage patterns

- *Drainage patterns under proposed conditions are maintained but the stormwater BMP's designed will provide significant improvement over the stormwater controls that exist today.*

(4) extent and type of existing native vegetation

- *The existing surfaces within The AURA are degraded with areas of distressed pavement, islands that have been used as parking and are compacted gravel, and slopes that have little to no topsoil left on them to properly grow groundcover to stabilize the slope.*

(5) extent and type of invasive vegetation

- *The top of the existing bank along Mill Brook is a mix of low-lying vegetation and poison ivy that will be removed as part of the project.*

(6) amount of impervious surface

- *The existing AURA has 31,151 sf of impervious area, which as mentioned above is in degraded condition and many of the landscaped islands are left as compacted gravel. In the proposed condition, the impervious coverage is increased by approximately 3,500 sf to 34,665 sf, but the AURA in the post construction condition will be better for Mill Brook and the wetland resources due to:*
    - *Increased vegetation*
    - *Vertical granite curbing*
    - *Stormwater BMP's, such as a water quality inlet.*
    - *Slope plantings that stabilize the top of bank to Mill Brook and provide topsoil to promote healthy plant growth.*

(7) wildlife and wildlife habitat

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- *The AURA under existing and proposed conditions will change little due to the minimal changes to the form and function of the parking lot.*

(8) intensity and extent of use

- *The intensity and use within the AURA will not change as the program won't change the parking, and stormwater will provide a better level of treatment.*

(9) intensity and extent of adjacent and nearby uses

- *The intensity and use of adjacent areas to the AURA will not change as the program won't change the parking, and stormwater will provide a better level of treatment as stated within (8).*

(10) capacity to provide resiliency to climate change

- The stormwater management will now meet State and local standards including such Low Impact Development BMP's as Rain Gardens and water quality units that will directly or indirectly clean the stormwater prior to discharge into the resource areas.

Alternative analysis:
Alternative 1: Renovation Only
An alternative to the selected option is to renovate the existing School, along with additions to the existing school. These alternatives also leave the existing previously disturbed areas (parking, etc.) as is, thus not improving the AURA from its current condition.
Alternative 2: Additions and Renovations
Another alternative to this project is to renovate portions of the existing school and add on additions to the structure. This would not meet the criteria for the District's educational vision for the school – leaving many critical elements of the educational plan unaddressed. These alternatives also leave the existing previously disturbed areas (parking, etc.) as is, thus not improving the AURA from its current condition.
Alternative 3: No Build
The proposed School would not be built in this scenario. This does not meet the program requirements for the school / district and the AURA would be kept in it's current condition which does not provide water quality within the stormwater system, doesn't provide trees to shade the wetlands and currently has a parking lot in need of repair.

As stated within the Riverfront Alternatives analysis, during the MSBA feasibility study, the team investigated multiple layouts for suitable solutions for the site. It was determined through that study that the selected alternative best met the programmatic requirements while accommodating the physical constraints of the parcel (resource areas, size, shape, slopes, etc.). There is very little change in terms of surface coverage between the existing condition and the proposed condition. In both cases, the area in question is utilized as both parking and as circulation, which require an impervious surface. Additionally, the proposed condition locates the AHS loading dock to this side of building and paved areas are required to allow delivery trucks the turning radii they need to navigate to the loading area off Mill Street and continuing the existing connection to that accessway for the school and the abutting condo complex. Parking has been consolidated to the south of the loop drive and a planted median will allow stormwater to recharge into the soil. We have added a sidewalk along Mill Brook Dr. which will allow students and visitors to safely walk along Mill Brook Dr. to the school and no longer in the roadway/parking lot. The sidewalk will turn north along the loop drive and connect to a small plaza at the entrance to the Minute Man Bike Path Connector. The paved space here is necessary as there are multiple modes of transportation meeting and navigating their way to/from the entrance of the school. In the final alternative shown, a small planted area within the plaza and at the base of the sports field light will be able to accept stormwater from the plaza. Because of the presence of the light pole, it is our professional judgement that is why this could be a rain garden, but should act in a similar way in that it will recharge the soil through a pervious material.

D. No activities or work, other than passive passage and resource area enhancement, are permitted within the first 25 feet of the Adjacent Upland Resource Area (measured horizontally from a resource area specified in Section 2, A(1) through (4). Except as part of Resource Area Enhancement or an Ecological Restoration Project, no vegetation may be disturbed, and leaf litter and natural debris shall remain in place. This No-Disturbance area shall at a minimum contain the same amount of area of undisturbed and natural vegetation from its pre-project state. A previously disturbed or previously developed 25-foot area shall be restored to a naturally vegetated state to the greatest extent practicable.

Under proposed conditions the impervious area within 25′ of the wetland resource area has been reduced by 1,370 sf and the pavement is located the same distance or greater distance from the wetland resource area along with all the improvements as illustrated above.

E. No new structure(s) shall be placed in the first 50 feet of the Adjacent Upland Resource Area (measured horizontally from a resource area specified in Section 2, A(1) through (4)), unless approved by the Commission in evaluation of existing total impervious surface (see Section F. below) within the 50-foot area compared to the proposed impervious surface, and other considerations for the improvement of the resource area and climate change resiliency.

Under proposed conditions the impervious area within 50′ of the wetland resource area has been reduced by 2,548 sf along with all the improvements as described above. The new stormwater BMP's and landscaping will aid in the climate resiliency.

F. Impervious surface.
(1) The total area of impervious surface within the Adjacent Upland Resource Area shall not increase over existing total area unless mitigation is provided and there is no impact on Resource Area values.
The existing impervious within the 25′ and 50′ buffer has been reduced but there is an overall increase within the 100′ AURA zone however the measures described above provide a much healthier and stabile resource area than under existing conditions.

(2) Impervious surfaces shall not intrude farther into the Adjacent Upland Resource Area than pre-project conditions unless the Commission in its sole discretion determines that the total area of impervious surface is significantly decreased or other mitigation is provided that serves to protect the resource area values. Impervious surface shall be kept as close as possible to the outer (upland) boundary of the Adjacent Upland Resource Area.
The proposed impervious area is not closer to the wetland resource area than in existing conditions and in most cases is 5′-7′ farther away and only equal at the existing culvert headwall.

G. The following activities may not be conducted in any portion of the Adjacent Upland Resource Area: changing of oil, refueling, or damage to other vegetation not scheduled for removal.
None of the uses listed above are to be performed under the proposed design and all re-fueling of construction vehicles will take place outside the AURA in designated areas.

P:\Projects\2017\17211.00 Arlington HS, 869 Mass Ave (Civil)\Documents\Item#1 AURA Analysis.doc

Infill Synthetic Turf Potential Health and environmental Exposure Related Testing
White Paper
By: John J Amato, P.E., JJA Sports, LLC

Introduction:

Infill synthetic turf fields have undergone a large degree of scrutiny regarding potential health and environmental related exposures over the past 20 years, both here in the United States and in Europe. Historically this effort originated as marketplace battles between natural turf grass sod producers and synthetic turf manufactures, due to synthetic turf marketing practices and loss of market share experienced by sod producers beginning early in the 21st century. Sod producers slowly identified health and environmental concerns regarding potential exposures. Two incidences, testing of improperly vulcanized rubber hammer handles in Germany and lead chromate found in synthetic turf in New Jersey, gained traction with health and environmental protection organizations creating a strong opposition to the replacement of natural turf grass fields with synthetic turf.

Since the onset of these concerns, a combination of State and Federal Regulations, general contaminated and hazardous materials testing, and product specific testing developed by the American Society of Testing Materials (ASTM) and European sport governing bodies, have become industry standards for health and environmental related exposures associated with the use of synthetic turf. This paper documents those recommended by JJA Sports, LLC for the testing of synthetic turf materials, which are included in our technical specification and product approval requirements.

Specifications for Testing Synthetic Turf Materials

The following is a brief listing of the testing recommended for inclusion in technical specifications for infill synthetic turf projects. This testing includes the most rigorous standards and regulatory requirements available in the Nation for synthetic turf materials. As many people are aware, the State of California is at the forefront of health and environmental exposure related testing regulations, one of which has been adopted by JJA Sports as criteria against which measure infill synthetic turf fields. Two tests included in our basic specification were developed by ASTM, through F08.65 Subcommittee on Synthetic Turf, to respond to testing for total lead content and extractable heavy metals. The most recent addition to our testing battery is based on the New York Department of Environment and Conservation standard for testing solids contaminated with Per and Polyfluoroalkyl Substances (PFAS**)** using EPA 533, currently in progress to develop a synthetic turf specific ASTM Standard Specification.

- CAM 17 (California Administrative Manual, Title 22) which is a law intended to protect drinking water sources from heavy metals, includes testing and threshold requiremetns for 17 heavy metals of concern. .

  The JJA Sports technical specification requires testing and compliance certification with CAM 17

- The ASTM 2765 Standard Specification for Total Lead Content in Synthetic Turf Fibers was developed a standard for testing fibers to comply with the Consumer Product Safety Improvement Act of 2008 for lead content. The current threshold is 100 ppm total lead which complies to children's toy levels.

  The JJA Sports technical specification requires testing and compliance certification in accordance with ASTM F2765.

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- The ASTM 3188 Standard Specification for Extractable Hazardous Metals in Synthetic Turf Infill Materials was developed a standard for testing fibers to comply with the Consumer Product Safety Toy Standard for heavy metals content. This method addresses health related exposures for Antimony, Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium.

  The JJA Sports technical specification requires testing and compliance certification in accordance with ASTM F3188.

- New York Department of Environment and Conservation provided a standard for testing solids using EPA 533 which was recently approved by the EPA, following Isotope Dilution techniques by Liquid Chromatography Tandem Mass Spectrometry as 537.1 M. Reporting limits shall not exceed 0.5 µg/kg (NYDEC part 375), and the reporting criteria shall be less than or equal to 1.0 µg/k kg (NYDEC part 375).

  The JJA Sports technical specification requires testing and compliance certification in accordance with the above or the ASTM version of this test when published.

<u>Studies Pertinent to Health and Environmental Exposures</u>

Recently a study on SBR infill material entitled, “ERASSTRI - European Risk Assessment Study on Synthetic Turf Rubber Infill - Part 3: Exposure and Risk Characterization” was published during March of 2020 which concluded the following:

- “As the final part of a Europe-wide study on the risk from synthetic turf infill consisting of rubber granules derived from end-of-life tires (ELT). exposure of sportspeople was assessed and compared with health-based reference values for various chemical substances. Based on information from previous project phases, exposure scenarios were established and exposure was calculated for oral, dermal and inhalation routes. Calculated cancer risks for exposure to polycyclic aromatic hydrocarbons were below 1 :1 million. Risk characterization ratios (RCRs) for non-carcinogenic substances were below 1, indicating no health concerns. For 2-hydroxybenzothiazole no toxicological data were found from which to derive a substance-specific reference value. A threshold-of-toxicological concern approach revealed maximum RCRs slightly above 1, which are acceptable, given the conservativism of the approach. ERAS STRI substantially improved the data available for assessing human health risks from using ELT-derived infill material. Overall, no health concerns could be identified for the use of synthetic turfs with ELT-derived infill material.”

During 2012 a study entitled, “Leaching of Zinc from Rubber Infill on Artificial Turf (Football Pitches) by Laboratory for Ecological Risk Assessment Netherlands, concluded, “the risks of zinc to public health are of no concern: the human toxicity of zinc is low and WHO drinking water criteria are not exceeded. Zinc concentrations in drainage water leaving a field were estimated to be (1.1-1.6 mg/L) when entering waterbodies. Dilution in the water, depends upon size and flow rate of the waterbody and or receiving stream. Considering the area of the contributing watershed upstream in Mill Brook, a mass balance analysis would assume a 100 to 1000 times dilution factor resulting in 1.1 µg/L to 16 µg/L which are far below aquatic thresholds sensitive species such as cutthroat trout, zinc sensitivity at 30 µg/L.

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Conclusions:

The testing required by outlined above and required by the JJA Sports technical specifications area considered to be current state-of-the art criteria by which to measure and evaluate health and environmental exposures associated of synthetic turf materials. Compliance with these requirements, addresses the potential health human exposure concerns related to synthetic turf.

As it relates to environmental exposure, values derived by the above noted testing, adjusted by mass balance resulting from runoff events reduces potential exposure down below critical levels for sensitive species.

Infill Synthetic Turf Synthetic Turf Use and Life Cycle Evaluation
White Paper
By: John J Amato, P.E., JJA Sports, LLC

Introduction:

A wide range of total use hours for the given field types have been published over the past 20 years. Depending on whether the information is obtained from a natural turf industry source or a synthetic turf industry source, the total hours of use could differ significantly. A reasonable criteria by which to compare these fields would be that an synthetic turf field provides 3-time the useful hours in a week than that of a natural turf grass field.

The following is a list of key considerations that one may take into account when selecting a synthetic athletic surface over a natural turf grass field.

- A synthetic turf field surface can be almost all-weather. Note that anything that is wet and retains moisture will freeze in below-freezing temperatures. There are times when a synthetic turf field is much too hot to be used. Infill synthetic turf fields recover from extreme weather conditions far more rapidly than natural turf grass fields.
- A natural turf field has limitations in very wet and extremely cold conditions. Again, anything that is wet and retains moisture will freeze in below-freezing temperatures. A natural turf-grass field with water or moisture throughout its full cross-section will take longer to thaw than a synthetic turf surface due to the mass of the frozen material.
- A well-constructed infill synthetic turf can handle 45 to 60 hours of use per week and can perform for multiple years without a rest season for its full useful life.
- A natural grass field should only be used 15 to 20 hours per week with a rest season. Re-sodding can diminish use hours. A higher level of maintenance and soil testing can help bring these up to 20 to 24 hours per week. The health of a natural turf grass field may require a rest season to maintain optimum performance levels.
- A synthetic turf field needs to have goal mouth areas replaced every four years. This is especially true on fields used for lacrosse.
- A synthetic field will eventually need to be fully replaced. A natural turf grass field may not.

Each synthetic turf field can provide 3-times the amount of use per week and further provides this use with far less weather related shutdowns than natural turf grass fields. An Owner can expect that one lighted synthetic turf field can provide the same number of use hours as three natural turf grass fields. Synthetic turf fields allow programs to start earlier and extend into later parts of the season without overuse damage typical of high use natural turf grass fields. From and environmental impact perspective having synthetic turf fields in a venue increases the available hours of paly and decreases the amount of land disturbance required to provide the same hours using natural turf grass fields.

Initial Investment Cost Comparison:

An irrigated natural turf grass playing field has a wide range of levels of quality and play it can be installed at. A midrange installation cost ranges between $400,000 and $600,000 including irrigation. High quality natural turf grass fields can cost over $1,000,000. The cost of a quality infill synthetic turf playing field ranges between, $1,000,000 to $1,200,000.

A synthetic turf field, constructed with new more durable fibers has a ten year life before needing to be replaced. Many last 12 to 14 years before being replaced. A natural turf grass field should be rebuilt every 25 years or so, but also has yearly sodding and turf repair costs as well and major repair costs associated

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multiple years for use. The best way to simplify analysis is to consider cost apply an average cost per year for yearly sodding to natural turf grass to cover this yearly cost. A typical turf grass field will require an average of $20,000 in re-sodding each year which will be added to the overall cost of the investment.

These initial investments can be compared based on hours of use or just basic installation cost. Considering reliable hours of use each year as a method of comparison, 1,040 hours per year for natural and 3,120 hours for synthetic (see Table 2 below for typical use hours). Table 1 below provides a comparison of cost per hour of use for the two field types including a yearly sodding impact on the natural turf grass field.

Turf Type	Initial Cost	Hours of Use	Replacement Life years	Yearly Sodding Cost Per Hour	Cost Per Hour Useful Life	Net Cost
Natural Turf	$600,000.00	1040	25	$19.23	$23.08	$42.31
Infill Synthetic	$1,200,000.00	3120	10		$38.46	$38.46

Table 1: Initial Cost Comparison

Water Use Reduction of Synthetic Turf:

A synthetic turf field eliminates the need for field irrigation. A typical field requires 1.0 inches of irrigation average each week. Assuming an average of 90,000 square feet in area for the two fields require over 14,400 cubic feet (100,000 gallons) per week of irrigation water). Considering irrigation would be recommended for 26 weeks of the year 114,400 cubic feet (2,600,000 gallons) reduction in projected water use.

Natural Turf Grass Vs. Synthetic Turf Maintenance:

Contrary to some beliefs, all fields, natural and synthetic, require maintenance. For natural turf-grass fields, the investment in maintenance is a function of the quality of the field and is greater for the higher quality fields. Because we are focusing on engineered natural turf-grass fields, we will use a higher level of maintenance for this discussion. Keep in mind that a trained natural turf-grass professional should oversee the maintenance and use of a high-quality natural turf-grass field to obtain the best results.

Synthetic turf requires cleaning weekly, as well as grooming every two weeks or 100 hours of use. It may also require a more aggressive grooming once or twice per year. Frequently used goal mouths can be expected to be replaced once or twice in eight years. The goal mouth areas should be evaluated each week, and areas of low infill should be filled and groomed to even out infill levels.

Natural turf grass fields require weekly mowing, seasonal fertilization, yearly overseeding and aeration, and seasonal dethatching. Table 2 below provides a comparison of the projected hours of maintenance for natural turf grass fields and infill synthetic turf grass fields. This comparison normally consists of comparing the total hours per year; however dividing by the projected hours of use per year provides the value of maintenance hours per hours of use, which represents a more realistic comparison value of maintenance costs.

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Natural Turf Grass Field - Practice Facility			*Synthetic Infill Field - Stadium Game Field*	
Natural Turf Grass Field Yearly Maintenance Hours			*Synthetic Turf Field Yearly Maintenance Hours*	
Labor	*Man Hours*		*Labor*	*Man Hours*
Mowing	*312*		*Cleaning*	*208*
Cultural Practices	*80*		*Grooming*	*104*
Repairs	*80*		*Repairs*	*40*
Structural Practices	*80*		*Topdressing Low Areas*	*40*
Painting	*200*		*Painting*	*100*
Total Man Hours	*752*		*Total Man Hours*	*492*
Use Hours Per Year	*1040*		*Use Hours Per Year*	*3120*
(20 Hours Per Week)			*(60 Hours Per Week)*	
Maintenance Hours Per Hour of Use	*0.72*		*Maintenance Hours Per Hour of Use*	*0.16*

Table 2: Maintenance Manhour Comparison

In review of the above table the total man-hours per year indicates that natural turf grass will require approximately 50% more man-hours to maintain in a typical year than an infill synthetic turf field. Taking the yearly projected hours of use for each field type into consideration shows that each hour of maintenance performed on a synthetic turf field results in more almost five times the hours of actual field use per hour of maintenance.

Total Cost Comparison Considering Maintenance Hours:

The effect of maintenance cost impact tot eh overall cost benefit analysis of natural turf grass fields Vs. infill synthetic turf results in a significant cost benefit of infill synthetic turf Vs. natural turf grass fields. Adding the cost of seeding, fertilization, and loss of use due to weather the benefit of synthetic turf increases. Take into account the environmental benefit of water savings and the cost of providing the water synthetic turf becomes a far better investment for a community.

Turf Type	Initial Cost	Hours of Use	Replacement Life years	Yearly Sodding Cost Per Hour	Cost Per Hour Useful Life	Effect Maintenance Per hour of Use	Net Cost
Natural Turf	$600,000.00	1040	25	$19.23	$23.08	$43.20	$85.51
Infill Synthetic	$1,200,000.00	3120	10		$38.46	$9.60	$48.06

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Synthetic Turf™ COUNCIL | TECHNICAL GUIDELINES

A GUIDELINE TO

RECYCLE, REUSE, REPURPOSE AND REMOVE SYNTHETIC TURF SYSTEMS

OCTOBER 2017

WWW.SYNTHETICTURFCOUNCIL.ORG

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The Synthetic Turf Council's (STC), *A Guideline to Recycle, Reuse, Repurpose and Remove Synthetic Turf Systems* was prepared by the Recycle & Reuse Committee. The Guideline is a revised version to the STC's document, "Removal, Recovery, Reuse and Recycling of Synthetic Turf."

This document update is dedicated to the work of nine individuals on the STC's Recycle Reuse Guideline Committee to whom special credit is due:

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DISCLAIMER

A Guideline to Recycle, Reuse, Repurpose and Remove Synthetic Turf Systems (this "Document") provides options and guidelines (collectively, the "Guidelines") to consider when making choices whether and how to recycle, reuse, repurpose and/or remove the synthetic turf. The Guidelines, however, are not exhaustive and there is a range of possibilities that may need to be considered that are not covered in this Document. The Guidelines are not, and should not be considered as, standards. This Document does not imply, suggest or in any way guarantee that performance issues could not arise if any or all of the Guidelines are followed and does not imply or suggest that if any or all of the Guidelines are not followed that performance issues will arise. The Guidelines are not intended to be and are not to be considered as safety standards and this Document does not imply that injuries or health issues are less likely to occur if the Guidelines are followed or more likely to occur if any or all of the Guidelines are not followed.

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INTRODUCTION

The Synthetic Turf Council (STC) is the world's largest organization representing the synthetic turf industry with over 200-member companies from over 10 countries. Founded in 2003, the STC serves as the global forum to promote, develop, grow and advocate for the synthetic turf industry. Due to a heightened sense of environmental awareness, many field owners, school boards, athletic directors, government agencies and municipal officials turn to synthetic turf systems for the water savings, reduced maintenance, longevity and safety benefits.

The goal of this document, *A Guideline to Recycle, Reuse, Repurpose and Remove Synthetic Turf Systems*, is to help the reader better understand the range of processes for identifying and managing the removal and disposition of a synthetic turf system once it may have reached the end of its useful life, or End-of-Life (EOL).

The diversity of members and encouragement of innovative technologies are reasons why the STC continues to advance the interests of the industry while solving the challenges presented by its customers. Some members provide innovative practices and programs that empower users to reduce their carbon footprint and landfill dependence.

Synthetic turf systems have a limited lifespan that ranges between 8 – 10 years. By the end of the decade, it is estimated that 750 or more synthetic turf fields will be removed annually in the United States. At an average of 80,000 sq. ft. of turf and 400,000 lbs. of infill per field, the amount of material to be handled is enormous. Synthetic turf systems are comprised of several component materials (e.g. turf, shock pad or underlayment) that most often must be separated to be recycled. Infill does not usually need to be separated to be reused or repurposed. The diversity of such component materials presents technical, economic and logistical challenges unlike other commonly recycled materials, such as plastic bottles, carpet and plastic bags. The STC encourages responsible parties to consider options to recycle, reuse and repurpose the synthetic turf systems.

This Guideline focuses more on synthetic turf sport fields than landscape and recreation applications as the sport fields systems constitute a higher volume of material. To that end, the STC believes it is important that all owners and responsible parties of synthetic turf systems utilize this Guideline as a resource to employ EOL opportunities to recycle, reuse and/or repurpose the synthetic turf systems.

TERMS AND EXAMPLES

The STC encourages the owners of existing synthetic turf system applications to recycle, reuse and repurpose the system components whenever possible. This Guideline best represents the intent of the STC's goals and objectives to implement best management practices in removing the synthetic turf and its components from various applications. The STC recommends that the responsible parties consider the following terms and examples of the terms in considering EOL options.

Recycle: A series of activities by which material that has reached the end of its current use is processed into material and utilized in the production of new products. Processing typically involves removal of contaminants and/or size reduction to satisfy specifications.

> *Example: The infill is recovered from a synthetic turf field during deconstruction. The infill is processed to remove rock, dirt and other contaminants; graded and tested to satisfy mesh size and distribution specifications; and then used as a feedstock to make a new product.*

Reuse: A discarded material or product is used in its original form for the same function as it was when new. The discarded material or product may be processed, typically by cleaning, repairing or otherwise refurbishing, with inspection and/or testing to confirm that it is suitable for continued use.

> *Example: A portion of the infill in a synthetic turf field is recovered during deconstruction. The infill is then processed to remove a portion of the contaminants; inspected and/or tested to confirm it meets specifications; and then is placed in a new or replacement field, whether on the same or a different site.*

Repurpose: A discarded material or product is used in its original form, but for a different function than when it was new. The discarded material or product may be processed, typically by cleaning, repairing or otherwise refurbishing; inspection and/or testing to confirm that it is suitable for continued use.

> *Example: A portion of the discarded turf is recovered from a synthetic turf field during the deconstruction phase. It is cleaned, repaired and used in a commercial or residential landscape application, batting cage, or soil amendment.*

RESPONSIBLE PARTIES

The project owner has ultimate responsibility of ensuring that the synthetic turf system is recycled, reused, repurposed and/or disposed of in a responsible manner. It is understood that owners most often rely on the consultant, contractor, turf manufacturer or vendor for information and direction in the planning stages of replacing the turf and its system components. The generator and its parties are responsible for understanding federal, state/provincial, municipal/local environmental laws before the synthetic turf system is removed. To avoid surprises, the STC recommends that owners consider working with an independent professional, consultant or knowledgeable industry representative.

A typical synthetic turf sports field is about 80,000 square feet (7,432 square meters). Infill can range from 3-9 lbs./ft^2 with an average of 5 lbs./ft^2, therefore existing fields range from 240,000 ± 720,000 lbs. of material to be removed from the surface of a field depending on the size of the field. Most of the fields installed in the United States use a combination of silica sand/tire crumb rubber or all crumb rubber infill. An average field is comprised of 400,000 lbs. of infill (5 lbs./ft^2) and 40,000 lbs. of turf (0.5 lbs./ft^2). An 80,000 ft2 sports field would translate in volume to ± 400 cubic yards (yd^3), or the equivalent of almost fourteen 30 cubic yard dumpsters of infill. The volume of the turf removed from the field depends on how it is collected (rolled, cut up or shredded) and will be considerable in volume. One thousand deconstructed fields represent 80 million square feet of turf weighing 40 million pounds and 400 million pounds of infill.

The first infilled (or so-called third generation) synthetic turf sports field was installed in the United States in 1997. By the of 2012, there were over 8,000 synthetic turf sports fields in use. Depending on its usage, exposure to intense sunlight, maintenance and other factors, a synthetic turf sports field will last 8 to 10 years before reaching the end of its useful life. Other factors that influence a sports field's useful life may include environmental exposure, severe overuse and/or improper use. Industry stakeholders have estimated the approximate number of synthetic turf sports fields that are deconstructed annually from 2013 through 2018 include: 2013 (365 fields); 2014 (570 fields); 2015 (325 fields); 2016 (450 fields); 2017 (600 fields); and 2018 (750 fields).

As an owner and/or responsible party of a synthetic turf sports field, it is imperative to know the type of synthetic turf system and manufacturer of the surface you will be replacing. If you do not have product information on the system, carpet, infill, shock pad, or other component, consider contacting the original manufacturer for this information. If there are any questions about the source of these materials, consider material testing in preparation of recycle, reuse, and repurpose options.

For field builders, sub-contractors and recyclers, the challenge of how to manage the synthetic turf system disposal options presents an opportunity to build upon the assortment of technologies and processes being developed to reduce landfill dependence. The industry continues to identify the best and most economical approaches to remove and process synthetic turf components that may have reached their EOL.

This document addresses questions often asked by field owners, school boards, athletic directors, government agencies and municipal officials such as:

- What choices are available to recycle, reuse and/or repurpose the components of the synthetic turf system?
- What are the economic, environmental and social factors that influence the EOL options?
- What tests, if any, will be required for the material to be recycled, reused or repurposed?
- What materials and/or components would be considered the appropriate EOL option?
- When is it time to make the decision to recycle, reuse, repurpose or landfill?
- What removal documentation may be required?

END-OF-LIFE OPTIONS FOR SYNTHETIC TURF SYSTEMS

Most often there is more than one option to recycle, reuse and repurpose the diverse synthetic turf system component materials before landfilling. There are economic, environmental and social responsibility factors to be considered by the owners and responsible parties before making an EOL decision about the materials. Many of the STC members utilize sustainable materials and processes that work to minimize any negative impact on the natural environment. The preferred way would be to find a recycler, donate or sell the material for another use. Matching donor surplus material with recipient needs, meets the objective of social responsibility.

Aside from benefitting society and the environment, donating the material can reduce capital expenditures and result in tax receipts and possibly contribute to a projects Leadership in Energy and Environmental Design (LEED) points. This Guideline provides a baseline of information to help better understand the materials and where to find sustainable solutions.

The following diagram, "Synthetic Turf System End-of-Life Options" is a simplified view of the decisions required and options available for a synthetic turf system removal. It shows the steps required to convert the synthetic turf materials into a form that is useful for recycling. Converting synthetic turf to a recyclable material that is useable cannot be accomplished at the point of removal. The cost of shipping is one of the biggest challenges associated with synthetic turf reclamation. Logistics, timing and the possible cost of testing the material to recycle and reuse may need to be considered.

STC member companies continue to develop new processes and offer more choices to collect,

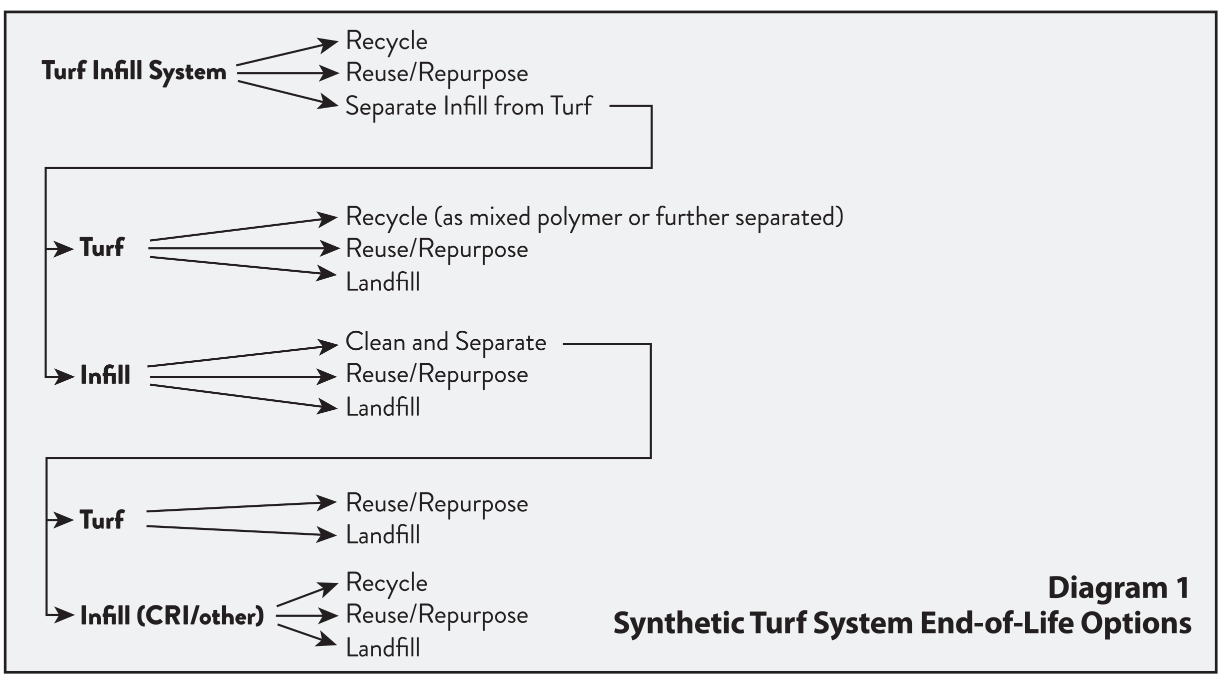

Diagram 1
Synthetic Turf System End-of-Life Options

separate, recycle, reuse and repurpose the synthetic turf systems. Some companies provide services to aid in the removal of the synthetic turf system; clean and warehouse turf that is suitable for reuse or repurpose; and/or provide logistics and transportation assistance. The removal of fields increases the options for handling, recycling and reusing the system components. Some specialty equipment removes the turf and its infill intact. Turf received in rolls can be processed into plastic pellets that are suitable for injection molding, rotational molding and profile extrusion. During the past 10 years, reused synthetic turf has become a popular option for residential and municipal landscape, roof gardens, pet parks, playgrounds, airport median strips and other landscape and recreation applications.

Further separation may be required to separate sand and debris from the infill depending on the EOL option. After the synthetic turf has been separated from the infill, the turf can be used in some post-consumer recycled products (e.g. plastic bags, carpet, turf backing and posts).

As with any recycle, reuse and recovery effort, the diversity of component materials may represent economic or technical challenges. Synthetic turf includes a variety of polymers such as polyethylene, polypropylene, polyester, nylon, styrene butadiene rubber and polyurethane. Polyester is the primary material for non-woven turf backing. Natural materials such as silica sand and calcium carbonate are present. The industry continues to research and identify the most economical and responsible way to process all turf components such as turf plastics, infill(s) and underlayment pads that need to be removed, recycled and reused.

Testing and/or separate assessments of some component materials (e.g. safety pad, drainage mat/tile, infill) when reusing and/or adding in combination with a new turf system. Some tests may include shock absorption, assessment of deformation and other performance criteria. For additional information, please refer to the *STC Guidelines for Synthetic Turf Performance* for performance testing information.

FIELD CONSIDERATIONS

The industry has developed specialized equipment to remove synthetic turf sports fields by cutting the material into sections, rolling it into easily transportable bundles and, in some cases, removing most of the infill. Synthetic turf for landscape and recreation use is not so easily removed and bundled because of its irregular shape.

It is important that the owner and responsible parties have a clear understanding of the project requirements to remove and/or replace system components including:

- What is the field base (e.g. drain board, aggregate, type of underlayment?)
- Is the turf adhered to the base?
- Is the base stable enough to work on without being disturbed/displaced?

- Who determines if the base is stable to work on without being disturbed or displaced?
- Who will be held responsible for damage for the base if it occurs during removal and installation of the new system?
- What are the field conditions (e.g. stability, infiltration rate)?
- What testing or documentation will be utilized to protect the contractor against future claims?
- What is the term of responsibility for the contractor for base performance after the work is completed?

The carbon footprint of a particular option (such as trucking at long distances) may be integrated into the decision-making process and lead responsible parties to invalidate such a specific option and look towards others. It is important to investigate all recycling and reuse options in the region before choosing to landfill the system components.

SYNTHETIC TURF SYSTEM COMPONENTS

This Guideline identifies the various synthetic turf system components that may be considered for options to be recycled or reused, including synthetic turf, infill, and shock pad and underlayment systems. See Table 2.

TABLE 2
SYNTHETIC TURF SYSTEM COMPONENTS

	Recycle Options	Reuse Options	Waste to Energy Options
Synthetic Turf			
Polyethylene	✔	✔	✸
Polypropylene	✔	✔	✸
Nylon	✔	✔	✸
Infill			
Crumb Rubber	✔	✔	✔
EPDM	✔	✸	✸
TPE	✔	✔	✸
Organic Infill	✔	✔	
Silica Sand	✔	✔	
Coated Silica Sand	✔	✔	
Shock Pad Underlayments			
PVC/NBR foam	✔	✔	✸
Polypropylene Composite	✔	✔	
Post-Consumer Tire Rubber	✔	✔	
Elastic Layer Underlayments			
Post-Consumer Tire Rubber	✔		✸
Combination Drainage Mats /Shock Pad Underlayments			
Expanded Polypropylene	✔	✔	✸
Cross-linked Polyethylene	✔	✔	✸
Drainage Mats and Strip Drains			
Polypropylene	✔	✔	✸
TPO		✔	

✸ Technically feasible but not commercially practiced.

SYNTHETIC TURF

Once the synthetic turf has been separated and processed it may be used for recycling, reuse or repurpose. Synthetic turf is produced from several polymers. Even perfectly clean turf contains a mix of LLDPE (linear low-density polyethylene), PP (polypropylene) and a coating of either polyurethane, hot melt polyolefin, or latex. Linear low-density polyethylene is used to produce most turf fibers, the largest component of turf. Nylon and polypropylene are also used, but to a much smaller degree. Polypropylene is typically used for the backing material, but backing is a smaller component than turf fiber. Heterogeneous polymer alloys can potentially be used as recycled content in some processes, but will have mechanical properties that are different and likely inferior to virgin or recycled polymers from single components. Options to reuse the synthetic turf system material include:

- Baseball: Batting cages, in front of dugouts, bullpens, indoor practice and hitting facilities;
- Golf: Driving ranges, lining for sand traps for erosion control, tee lines, driving mats;
- Sports Fields: grass field sidelines, running track protective strips, band practice field, indoor typical use practice and play fields;
- Landscape and Recreation: Play areas, small landscape areas, highway erosion control, dog runs, pet parks, and equestrian stables.

INFILL

Synthetic turf component infills may include crumb rubber, sand, thermoplastic elastomers (TPE), ethylene propylene diene monomer (EPDM) and a variety of organic infills. Infill can be extracted, recycled, reused and repurposed from an existing field. The owner may reuse the extracted infill in a new synthetic turf field or existing field. In many cases, additional new infill may be added to the quantity of reused infill on a replacement field. Fields certified by an international sports governing body (e.g. FIFA, World Rugby) may or may not allow for reused material in the new turf system. In some cases, infill may have to be tested and/or verified that it meets the requirements of an approved product and/or system. Sometimes reusing or repurposing the infill may represent a cost saving to the owner. Reusing the infill may allow a project to qualify for the additional LEED credits beyond those awarded for the first use of the infill.

It is recommended that the owner or responsible party should evaluate the following:

- A reliable sample collection method;
- Type of infill and compatibility with the new turf system;
- Contaminants and debris that may have accumulated over time;
- Performance properties (e.g. exposure to the elements, wear and debris);

- Testing of infill in accordance with applicable standards and certification guidelines;
- Percentage of supplementary infill;
- Testing of proposed system as required for the application (see *STC Guidelines for Synthetic Turf Performance*);
- Metallic, non-ferrous and organic components; and
- Applicable industry patents and warranties.

CRUMB RUBBER

Crumb Rubber is derived from scrap passenger and truck tires that are ground up and size reduced to a range of mesh sizes through a recycled ambient (8-20 mesh) or cryo-genic (10-30 mesh). Crumb rubber, historically the most widely used infill in the synthetic sports fields and landscape installations, can be coated with colorants, sealers, or anti-microbial substances to provide specific benefits. Crumb rubber infill can be extracted and reused in other end use applications or synthetic turf systems.

In most cases, the crumb rubber and sand will need to be separated before reusing the crumb rubber in the manufacturer of tire-derived products. The crumb rubber may also need to be cleaned and screened to further remove unwanted fine particulates and to reduce the size of the crumb rubber. Different turf systems use varied sizes and proportions of rubber and may require evaluation of compatibility with a proposed turf system. In most cases, however, it has not been necessary to separate the rubber and sand when reusing the materials again in most existing fields.

EPDM AND TPE

EPDM (ethylene propylene diene monomer) and TPE (thermo plastic elastomer) are polymeric elastomers with fillers that offer high resistance to abrasion and wear under a reasonably elevated temperature. The products normally have a UV stabilizer to give long-term weathering. These products will vary from one manufacturer to another. It is suggested to review independent testing regarding heavy metals, temperature, UV resistance and other tests that are required. EPDM and TPE are available in a variety of colors and have proven durability in all types of climates. Both products can be recycled or reused.

ORGANIC INFILL

Plant-based organic infill comes in several formats including, but not limited to: blended coconut fibers and cork; coconut fibers only; cork only; and walnut shells.

SILICA SAND

Well-graded silica sand is one of the original infill materials utilized in synthetic turf systems. This natural mineral is non-toxic and chemically stable subject to the percent purity of the silica sand. Silica sand

that has agglomerated particles or are calcareous should not be used. Silica sand is typically tan, off-tan, or white in color. The preference in particle shape for this industry is round or sub-round. Silica sand can be used in conjunction with many other infills on the market to provide a safe and realistic playing surface.

COATED SILICA SAND

Coated silica sand may consist of an acrylic, urethane, ceramic or other polymer that covers the sand grain in whole. The polymer that coats the sand particle should not wash off once installed and provides UV for long-term durability. The original silica sand, before being coated, is a hard grain, round to sub-round, non-agglomerated, non-calcareous material.

SHOCK PADS AND UNDERLAYMENTS

Underlayments, described as shock pads, elastic or e-layers, integrated drainage systems, drainage mats and strip drains, each have their own purpose. The following provides examples of use and options for EOL.

SHOCK PADS

Shock pads offer an added level of protection and consistent playability to the playing surface and are designed to contribute to a safe g-max level throughout a synthetic turf field's life. Roll out or panel systems are available and can be permeable or impermeable. Some shock pads can replace all or portions of the stone base and provide both shock attenuation and drainage, while others are used in combination with a traditional stone and drainage base. Pads can be placed directly over asphalt or cement stabilized surfaces.

Various materials that are used in shock pads include PVC/NBR (polyvinylchloride/nitrile butyl rubber) foam, polypropylene, composites, polyurethane, virgin materials and post-consumer tire rubber. Some manufacturers of shock pads will accept re-covered product for recycling. Select pads can also be reused for other uses such as golf mats and farm animal mats. Some shock pads last more than one turf lifecycle of 8 – 12 years.

ELASTIC LAYERS OR E-LAYERS

Elastic layers or E-Layers are poured in-place applications. The product is permeable and is typically comprised of tire rubber granulate with a polyurethane binder, or the same combined with small gravel particles. E-layers can vary in thickness across the surface and do not have seams. Artificial turf can be either loosely laid on top, or glued to the e-layer (i.e., for field hockey). Materials include post-consumer tire rubber used in combination with a polyurethane binder.

Although E-layers are not currently being recycled, they may be able to be reused, or repaired and reused depending on initial quality and binder content.

INTEGRATED DRAINAGE UNDERLAYMENT

Drainage pad underlayments are designed to replace the stone base and act as both a base support and drainage system for turf. Roll out or panel systems are utilized. Materials used for the various product offerings include expanded polypropylene or cross-linked polyethylene. Some products can be recycled and incorporated into a new drainage pad, while others may be reused or repurposed into other products. Some drainage pads can be used for multiple turf life cycles.

DRAINAGE MATS AND STRIP DRAINS

Drainage mats and strip drains are designed to act as both a base support and a single-sided drainage system for turf. Materials used for the various products include polystyrene, polypropylene and TPO (thermoplastic olefin). Polypropylene products can be reused and recycled.

CHAIN OF CUSTODY CERTIFICATION

Once decisions have been made to recycle, reuse, repurpose or landfill the synthetic turf system components, the STC recommends the responsible parties complete a two-part Chain of Custody Certification (COC) that includes the following:

Part 1: Chain of Custody Certification – Project Parties and Materials

The template provides chronological documentation from the project owner to the contractor, disposition company and verification agent identifying a transfer of material from person to person.

Part 2: Chain of Custody Certification – EOL Management

The template provides chronological documentation by load and EOL option (e.g. Recycle, Reuse, Repurpose, disposal).

When using the STC's Chain of Custody Certification templates, the STC recommends following the sequence in which you intend to remove the materials. For example, if you are removing a synthetic turf field with infill and a shock pad, you would begin by documenting the loads of infill removed, then the synthetic turf and finally the shock pad.

The following four pages include two different project scenarios that represent examples of how to complete the COC Part 1 and Part 2 for Project Scenario One and Project Scenario Two.

PROJECT SCENARIO ONE

Part 1: Chain of Custody - Project Parties and Materials

Example 1A: Documenting the removal of an intact field (turf and infill) at George Washington High School for RECYCLYING and REPURPOSING

The "Chain of Custody Certification—Project Parties and Materials" form includes the project parties and materials that will be moved to specific destinations. The intention in this example is to remove an intact 40,000 sq. ft. field.

First, estimate total weight: 5.5 lbs. per sq. ft. x 40,000 sq. ft. field = 220,000 lbs. The weight/area value is given as an example and each specific system has its own value which should be used in the calculations.

Note that 20,000 sq. feet will be RECYCLED (new use; posts) and 20,000 sq. ft. will be REPURPOSED (i.e. same material, different use; e.g. batting cage).

Part 1: Chain Of Custody Certification - Project Parties and Materials **Example 1A**

PROJECT NAME: **George Washington High School**

Complete Required Project Parties and Project Materials Information

Project Parties	Business Organization	Contact Person	Phone Number	Address	City	ST.
Owner	George Washington HS	Joe Smith	333-333-3333	123 East Main Street	Homer	CT
General Contractor	XYZ Construction Company	Mike Franks	444-444-4444	456 Walker Drive	Providence	RI
Disposition Company	ABC Recycling Company	Steven Dobbs	555-555-5555	789 Franklin Road	East Haven	CT
Verification Agent	John Doe Architects	John Doe	666-666-6666	10 Dyer Street	New Haven	CT

Project Material(s)	Identify Material	Recycle		Reuse		Repurpose		Landfill	
Totals-Area & Weight		Area ft^2	Lbs.	Area ft^2	Lbs.	Area ft^2	Lbs.	Area ft^2	Lbs.
Turf Type(s)	Turf name/type	20,000	10,000	0	0	20,000	10,000	0	0
Infill(s)	Crumb rubber infill + sand	20,000	100,000	0	0	20,000	100,000	0	0
Shockpad/Underlayment(s)									
Total		Total	110,000	Total	0	Total	110,000	Total	0

Authorization Party	Authorized Signature	Printed Name & Email Address	Date	Phone Number
Owner	Joe Smith	Joe Smith sample@email.com	6/10/17	333-333-3333
General Contractor	Michael Franks	Michael Franks sample@email.com	6/10/17	444-444-4445
Disposition Company	Steven Dobbs	Steven Dobbs sample@email.com	6/10/17	555-555-5566
Verification Agent	John Doe	John Doe sample@email.com	6/10/17	666-666-6661
EOL Option Disposition:	Recycle: Posts; Repurpose - Batting Cage on Site			
Calculation Notes:	Turf = .5 lbs/sq.ft. x project total square ft. (40,000 sq. ft.) = 20,000 lbs.			
	Infill (crumb rubber & sand) = 5.5 lbs/sq. ft. x project total sq. ft. (40,000 sq. ft.) = 200,000 lbs.			

PROJECT SCENARIO ONE

Part 2: Chain of Custody Certification – EOL Management

Example 1B: Documenting the EOL management of the project materials

The "Chain of Custody Certification—EOL Management" form includes the end-of-life (EOL) options for each component per shipping load and requires a third-party verification signature to verify the delivery of the material to the specified EOL option.

First, choose the end of life option: Recycle; and select deposition material: Turf and Infill. Next, provide the corresponding information in each column.

Part 2: Chain of Custody Certification - EOL Management **Example 1B**

PROJECT NAME: George Washington High School

Choose the End of Life Options. Identify project material and EOL Product(s)/Application(s). Complete corresponding information in each column.

Require Verification Agent Signature of EOL delivery.

Load No.	End of Life Option(s)	Identify Material(s)			Ship Date	Ship to Company Name or Site Name (EOL Option)	Bill of Lading or Seal/Container #	Total lbs.	Date Verified Completed	Verification Agent Signature
		Turf	Infill	Pad						
1	Recycle	X	X		6/15/17	ABC Container Company	123456	40,000	6/17/17	John Doe
	Reuse									
	Repurpose									
	Landfill									
Identify End Of Life Product(s)/Application(s): Recycled Posts/Infill/Sand										
2	Recycle	X	X		6/16/17	ABC Container Company	123457	40,000	6/18/17	John Doe
	Reuse									
	Repurpose									
	Landfill									
Identify End Of Life Product(s)/Application(s): Recycled Posts/Infill/Sand										
3	Recycle	X	X		6/17/17	ABC Container Company	123458	30,000	6/19/17	John Doe
	Reuse									
	Repurpose									
	Landfill									
Identify End Of Life Product(s)/Application(s): Recycled Posts/Infill/Sand										
4	Recycle									
	Reuse									
	Repurpose	x	x		6/23/2017	George Washington HS	onstie	**110,000**	6/27/17	John Doe
	Landfill									
Identify End Of Life Product(s)/Application(s): Recycled Posts/Infill/Sand										

PROJECT SCENARIO TWO

Part 1: Chain of Custody - Project Parties and Materials

Example 2A: Documenting the removal of an intact field (turf and infill) at Lincoln Middle School for LANDFILLING, REUSE and RECYCLYING

The intention here is to remove, by materials, a 90,000-sq. ft. field. First, estimate total weights of individual material(s): Infill is estimated at 5 lb. per sq. ft. of sand and rubber. Total = 5 lb. per sq. ft. x 90,000 sq. ft. = 450,000 lbs. The first half or 225,000 lbs. will be REUSED in Lincoln Middle School's new replacement field (Example 2A). The remaining half or 225,000 lbs. will be sent to a LANDFILL (Example 2B).

Next, estimate the synthetic turf weight. Synthetic turf weight is estimated at .5 lbs. per sq. ft. Total synthetic turf weight = 4.5 lbs. per sq. ft. x 90,000 sq. ft. or 45,000 lbs. which will be shipped from site for RECYCLING (Example 2A).

Part 1: Chain Of Custody Certification - Project Parties and Materials **Example 2A**

PROJECT NAME: **Lincoln Middle School**

Complete Required Project Parties and Project Materials Information

Project Parties	Business Organization	Contact Person	Phone Number	Address	City	ST.
Owner	Lincoln CSD	Joe Smith	333-333-3333	1234 East Main Street	Homer	CT
General Contractor	HHC Construction Company	Mike Franks	444-444-4444	138 Walker Drive	Providence	RI
Disposition Company	Clean Recycling	Steven Dobbs	555-555-5555	1453 Franklin Road	East Haven	CT
Verification Agent	John Doe Architects	John Doe	666-666-6666	2523 Dyer Street	New Haven	CT

Project Material(s)	Identify Material	Recycle		Reuse		Repurpose		Landfill	
Totals -Area & Weight		Area ft^2	Lbs.	Area ft^2	Lbs.	Area ft^2	Lbs.	Area ft^2	Lbs.
Turf Type(s)	Competitive Edge Turf	90,000	45,000	0	0	0	0	0	0
Infill(s)	Crumb Rubber Infill & Sand	0	0	45,000	225,000	0	0	45,000	225,000
Shock Pad									
Total		Total	45,000	Total	225,000	Total	0	Total	225,000

Authorization Party	Authorized Signature	Printed Name & Email Address	Date	Phone Number
Owner	Joe Smith	Joe Smith sample@email.com	8/10/17	333-333-3333
General Contractor	Michael Franks	Michael Franks sample@email.com	8/10/17	444-444-4445
Disposition Company	Steven Dobbs	Steven Dobbs sample@email.com	8/10/17	555-555-5566
Verification Agent	John Doe	John Doe sample@email.com	8/10/17	666-666-6661
EOL Option Disposition:	Recycle 100% Turf for Posts; Reuse 50% Infill/Sand in Replacement Field at Lincoln Centeral SD; Landfill 50% Infill/Sand.			
Calculation Notes:	Turf = .5 lbs./sq.. x project total square ft. (90,000 sq. ft.) = 45,000 lbs. = 100% "Recycle"			
	Infill (crumb rubber & sand) = 5 lbs./sq. ft. x project total sq. ft. (90,000 sq. ft.) = 450,000 lbs. = 50% Reuse; 50% Landfill			

PROJECT SCENARIO TWO

Part 2: Chain of Custody Certification – EOL Management

Example 2B: Documenting the EOL management of the project materials delivered to a landfil

Choose the end of life option: Landfill; and select deposition material: Infill. Complete the form with the corresponding information and third-party verification signature to verify the delivery of the material to the specified EOL option, in this case, the landfill.

Part 2: Chain of Custody Certification - EOL Management

Example 2B

PROJECT NAME: Lincoln Middle School

Choose the End of Life Options. Identify project material and EOL Product(s)/Application(s). Complete corresponding information in each column.
Require Verification Agent Signature of EOL delivery.

Load No.	End of Life Option(s)	Identify Material(s)			Ship Date	Ship to Company Name or Site Name (EOL Option)	Bill of Lading or Seal/Container #	Total lbs.	Date Verified Completed	Verification Agent Signature
		Turf	Infill	Pad						
1	Recycle									
	Reuse									
	Repurpose									
	Landfill		X		6/13/17	ABC Transport	UB1234	44,000	6/13/17	John Doe
Identify End Of Life Product(s)/Application(s): Landfill 50% of Project Infill/Sand										
2	Recycle									
	Reuse									
	Repurpose									
	Landfill		X		6/13/17	ABC Transport	UB1235	44,000	6/13/17	John Doe
Identify End Of Life Product(s)/Application(s): Landfill 50% of Project Infill/Sand										
3	Recycle									
	Reuse									
	Repurpose									
	Landfill		X		6/14/17	ABC Transport	UB1236	44,000	6/14/17	John Doe
Identify End Of Life Product(s)/Application(s): Landfill 50% of Project Infill/Sand										
4	Recycle									
	Reuse									
	Repurpose									
	Landfill		X		6/14/17	ABC Transport	UB1237	44,000	6/14/17	John Doe
Identify End Of Life Product(s)/Application(s): Landfill 50% of Project Infill/Sand										

CHAIN OF CUSTODY CERTIFICATION TEMPLATES (PARTS 1 & 2)

The STC guideline templates for Chain of Custody Certification—Project Parties and Materials (Part 1) and End of Life (EOL) Management (Part 2) are available for free download in .XLSX format here:

Part 1: Chain of Custody Certification-Project Parties and Materials—Download Now (.XLSX)

http://www.syntheticturfcouncil.org/resource/resmgr/guidelines/STC_Template_FORM_-_COC_PM.xlsx

Part 2: Chain of Custody Certification-EOL Management—Download Now (.XLSX)

http://www.syntheticturfcouncil.org/resource/resmgr/guidelines/STC_Template_FORM_-_EOL_MGM.xlsx

LOOKING AHEAD

Innovative technologies are being developed for higher end uses for recycled and reused turf every day. The members of the Synthetic Turf Council plan to lead this effort to develop better and more environmentally friendly options for the second life of synthetic turf surfaces.

Synthetic Turf™ COUNCIL

The Synthetic Turf Council (STC) is the world's largest organization representing the synthetic turf industry, representing over 200 companies with operations in 10 countries. Founded in 2003, the STC assists buyers and end users with the selection, use and maintenance of synthetic turf systems in sports field, golf, municipal parks, airports, landscape and residential applications. It is a resource for current, credible and independent research on the safety and environmental impact of synthetic turf, as well as technical guidance on the selection, installation, maintenance and environmentally responsible disposal of synthetic turf. Membership includes builders, landscape architects, testing labs, maintenance providers, manufacturers, suppliers, installation contractors, infill material suppliers and other specialty service companies. For more information, visit www.syntheticturfcouncil.org.

To find STC member companies that provide field removal, recycle, and reuse services, please visit the STC Online Buyers' Guide & Member Directory at http://stc.officialbuyersguide.net.

SYNTHETIC TURF COUNCIL (STC) GUIDELINES

- A Guideline to Recycle, Reuse, Repurpose and Remove Synthetic Turf Systems
- Considerations When Buying Synthetic Grass for Landscape Use
- Guidelines for Crumb Rubber Infill Used in Synthetic Turf Fields
- Guidelines for Maintenance of Infilled Synthetic Turf Sports Fields
- Guidelines for Minimizing the Risk of Heat Related Illness
- Guidelines for Synthetic Turf Base Systems
- Guidelines for Synthetic Turf Performance
- Suggested Environmental Guidelines for Infill
- Suggested Guidelines for the Essential Elements of Synthetic Turf Systems

Synthetic Turf
COUNCIL

SYNTHETIC TURF COUNCIL
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FAX: + 1 (443) 640-1031

ONLINE BUYER'S GUIDE AND
MEMBER DIRECTORY
stc.officialbuyersguide.net

SYNTHETICTURFCOUNCIL.ORG

Conservation Commission Requests for Information #3

Re: Arlington High School Expansion SCI File #17211.00

RE: Conservation Requests June 25, 2020 Item #3 Climate Change Summary for Turf Fields

At the request of the Conservation Commission, in addition to the heat island analysis provided, the following details other factors in the alternative analysis for selecting turf fields over grassed fields.

For some background on how this alternative was selected, the Arlington High School Building Committee has held public meetings for over three years and many discussions centered on the benefits of installing an artificial turf field (similar to the one currently at the high school stadium) for all other sports. As designed the new artificial turf fields will serve baseball, softball, soccer, lacrosse, and football. This is due to the ability to layout out overlapping sports within the same footprint. Many discussions regarding costs/benefits analysis occurred when the Committee needed to reduce project costs. It was agreed by the 18-person committee that artificial turf fields versus natural grass turf fields are essential for the high school program. The artificial turf, with its superior drainage, will allow for six (6) more weeks of outdoor activity for Arlington students. This benefit was paramount to the educators, parents, and residents of the School Building Committee.

These additional six weeks of outdoor activity also assumes that the grassed fields remain in playable condition for the entire fall and spring season. In actuality, the grassed fields typically become muddied and bare – causing erosion and siltation – most season due to challenging weather and over-use for that surface versus student activity needs. The selection of turf fields will remove that siltation source to the resource areas.

Regarding the turf meeting ecological standards, the project will now meet the specifications of the New York State Standards per the request of the Commission, the strictest guidelines that are available. Additionally, the project meets all the MA DEP Performance standard for how the turf fields would affect the waters and wetland plantings, as there are no studies nor data available showing that any runoff from turf fields has a detrimental affect on those resources for us to meet.

P:\Projects\2017\17211.00 Arlington HS, 869 Mass Ave (Civil)\Documents\Permitting\Conservation Commission\NOI\Con Com Additional Information\ Item#3 Climate Change Summary for Turf Fields - Ecological Health.doc

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Infill Synthetic Turf Field Heat Island Effect
White Paper
By: John J Amato, P.E., JJA Sports, LLC

Introduction:

Heat Island Effect is a complex matrix of energy transfer in built-up areas, which through a combination of; heat storage within urban materials, reflective behavior from those materials, and release of the heat stored within those materials, results in a warming of the air as compared to that of surrounding non built-up areas. This warming occurs within the surfaces and within the air canopy. According to the Federal Environmental Protection Agency small cities experiencing heat island effect have a daytime increase of 2°F to 6°F and a nighttime temperature increase of as much as 22°F. Heat island effect results in increased energy consumption and greenhouse gas pollution, increases in heat related illnesses, warming of runoff waters impacting water quality, and warming of waterbody and wetland habitats.

The advent of synthetic turf and its tendency to become hot during the midday of summer months has increased concerns relating to its potential contribution to heat island effect. For many years users of synthetic turf have voiced concerns relating to how hot these fields get during peak day solar radiation, during the summer months. These surfaces can become too hot to play on. Based on temperature data from a wide array of sources, synthetic turf surface temperatures during peak day solar radiation, during June, July, and August can be elevated over adjacent air temperature by as much as 75°F. This temperature increase is significant, but does infill synthetic turf contribute to a community's heat island effect?

Solar Radiation Properties:

To understand if the summer heating of synthetic turf constitutes a localized heat island effect we must better understand the energy transfer that takes place in commonly known heat island materials and how they relate to synthetic turf grass. In 2009 a paper entitled, "Modeling the Thermal Effects of Artificial Turf on the Urban Environment by Neda Yaghoobian and Jan Kleissl", published in the Journal of Applied Meteorology and Climatology, attempted to address that specific issue. They modeled the effects of artificial turf on the urban canopy layer. They utilized energy balance, air and surface temperatures, and building cooling loads generated from common ground surface materials such as: asphalt, concrete, and grass, using heat transfer modeling of radiation, convection, and conduction. Temperatures of Urban Facets in 3D (TUF3D) software model was used on clear summer day conditions in San Diego, California to evaluate this potential.

Inputs into this model included thermal and radiative properties of natural grass, artificial turf, concrete, and asphalt. Natural turf grass was included as a baseline goal for a non-heat island surface. Concrete and asphalt were included due to their known thermal behavior in urban environments. The specific radiative properties included; thermal conductivity, heat capacity, momentum roughness, thermal roughness, albedo, and emissivity. Two of the properties; heat capacity and albedo stood out as prime properties in this study. Albedo is proportion of radiation that is reflected up from a surface and includes both short and longwave radiation. Heat capacity is the amount of heat needed to raise a material temperature one degree. These two properties become critical and represent energy reflected up and into the canopy during the day, warming vertical surfaces, and stored heat released into the canopy at night. Also included in the model was the mass of the various materials. Of the materials evaluated concrete and asphalt had a high mass and the ability to store more heat energy during the day for release at night. Artificial turf and natural turf grass have low mass and cannot store large amounts of heat and therefore have very limited heat release at night.

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Light radiation from the sun arrives to the earth's surface in ultra violet, visible, and infrared spectrums. In that order, they represent shortest to longest wave lengths. The shorter the wave length, the higher the amplitude, and the hotter the light. The opposite is true for long wave radiation. Of the four materials artificial turf has the lowest albedo and reflects the lowest amount of heat energy during the day.

The results of the model were a surprise to those participating in the study. They found the lack of heat mass, inability to store heat, and the low albedo resulted in a slight decrease in energy required to cool buildings during both day and night. The low albedo of artificial turf results in a reduction of shortwave radiation reflecting from the surface to the building walls and an increase in the cooler longwave radiation reflecting to the same walls. The end results is that based on their analysis synthetic turf does not contribute to heat island effects in a community.

At the time of the study they did not have field data that could verify these properties.

Synthetic Turf Temperature Field Data:

As part of project closeout work for some of JJA Sports New England, during summer months a series of temperatures were taken to assess temperature difference around, on the surface, and within the synthetic turf system. Temperatures were taken when completion dates fit with the summer window between 2007 and 2009 for general knowledge. These fields were new fields and had not undergone fiber breakdown typical of older fields. Infill material was generally covering the newer fibers and limited infill was exposed to the sun.

More recently thermal evaluation was been completed on fields in Westford and Chelmsford, Massachusetts in support of this document. These fields had significant fiber breakdown and infill material was somewhat exposed due to a loss of fiber mass.

Under both data collection efforts air temperatures were obtained off the field at a 3 foot height above grade. This location was, more often than not, a grass area off from the edge of the field. The next air temperature was generally within the synthetic turf field, away from edge of the turf, at a similar 3 foot height above grade. More recently, where a track encompassed the synthetic turf field, an air temperature reading was obtained in the center of the track lanes at a 3 foot above grade. The next reading included an air temperature reading obtained at a height of 1 foot height above the field. A surface temperature reading and a reading within the infill material were the final temperature readings.

Conditions varied on each reading day. Early on in the process, it was quickly determined that cloud cover blocking the sun effectively reduced readings at all heights and in all locations. As a reference description, where surface temperatures were very hot to touch, cloud cover rapidly brought surface temperature down to a warm temperature. This was consistent with relatively low surface weight, and low heat capacity of fibers exposed to solar radiation. Fibers stored very little heat in their small mass, and that heat quickly dissipated when the energy source was removed.

Generally all fields followed a similar trend in relative temperatures from reading location to reading location. Off field and on field at the 3 foot height tended to be within 2°F. Temperatures at the 1 foot height above the field ranged from equal, to as much as 6 degrees above the 3 foot height reading. The average delta between these two readings was plus 4°F. The difference between the 1 foot reading and the surface ranged from 1 degree obtained under a summer time 7:30 pm reading to as much as 56

degrees higher on the surface. Infill temperatures averaged approximately 15° higher than the reading at the 1 foot height. As the sun dropped in the evening temperatures generally balanced with air temperatures. The infill did retain its heat longer, but was on a dropping trend with surface temperatures being lower than the infill below. See table 1 below.

These values represent thermal characteristics similar to non-heat island conditions where air temperatures above the surface in question closely match those of the air off surface and the exposed fiber provides no heat capacity to warm evening conditions.

Location	Date	Time	Weather Conditions	Product and Infill Material	Air Temp Off Field (°F)	Air Temp Track +3' (°F)	Air Temp 3 Feet Above Field (°F)	Air Temp 1 Foot Above Field (°F)	Air temp at Turf Field Surface (°F)	Infill Material Temp 1/8" to 1/4" Below Surface (°F)
Westford Academy Stadium Field	6/19/20	7:30 AM	Light Clouds Light Wind	FieldTurf/Sand and SBR	82.8	83.8	82.8	82.4	81.7	92.5
Westford Academy Stadium Field	6/19/20	5:30 AM	Light Clouds Light Wind	FieldTurf/Sand and SBR	88.9	91.6	90.0	91.2	119.5	104.9
Westford Academy Stadium Field	6/19/20	3:30 PM	Light Clouds Light Wind	FieldTurf/Sand and SBR	90.7	90.7	93.2	95.5	142.5	108.2
Westford Academy Stadium Field	6/19/20	1:30 PM	Light Clouds Light Wind	FieldTurf/Sand and SBR	91.6	92.3	94.7	100.2	155.7	124.3
Chelmsford McCarthy Middle School	6/6/20	1:00 PM	Windy with Clear	Sprinturf/Sand and SBR	91.5		91.8	93.2	149.4	118.2
Chelmsford McCarthy Middle School	6/5/2	3:00 PM	Windy with Wispy Cloud Cover	Sprinturf/Sand and SBR	82.0		84.7	86.3	103.6	91.8
Westford Nutting Road Fields	6/5/20	3:20 PM	Windy with Clear Skies	Field Turf/Sand and SBR	86.1		87.3	93.1	113.5	104.9
Danbury Rogers Park	6/22/09	12:20 PM	Cloudy	Field Turf/Sand and SBR			73.6	76.6	99.7	82.6
Worcester Polytech Alumni Field	8/7/2007	2:15 OM	Clear	Field Turf/Sand and SBR	93.0		95.0		133.0	105.0
Waterbury Field	9/4/07	11:15 AM	Clear	Sprinturf/Sand and SBR	79.5		79.5	86.1	116.8	93.8
Waterbury Field	9/5/2007	12:15 PM	Clear	Sprinturf/Sand and SBR	84.8		84.8	86.1	126.0	91.5
Waterbury Field	9/6/2007	1:00 AM	Clear	Sprinturf/Sand and SBR	86.0		86.1	95.0	136.1	94.0
Walpole High School Turco Field	10/16/07	2"00 PM	Clear	A-Turf/Sand and SBR	63.0		67.0	73.0	98.0	
Average Values					85.2	91.5	86.5	90.7	126.7	104.3

Table 1: Synthetic Turf Field Thermal Summary Data

Heat Impacts to Rainwater and Surrounding Waterbodies:

Rainwater temperatures increase as surface flow travels along hotter temperature surfaces during the summer season. The hotter the day and the later into the day a rain event takes place, the higher the potential for the heat capacity of the receiving surface to raise the water temperature. Surfaces such as concrete and asphalt have a high heat capacity causing a buildup in the materials heat storage during the summer days. Rainwater can pull this heat from a surface and raise the temperature of the runoff. These raised water temperatures can impact the temperature and water quality of waterbodies downstream of these surfaces.

As discussed above, a critical aspect of synthetic turf fibers as it relates to heat island impacts is that these fibers have a very small mass and a low heat capacity. With that, they have very little heat mass to alter the temperature of rainwater as it strikes the ground and comes in contact with the fibers. Further and equally important, as cloud cover, which is typical with rain events, blocks the sun the surface temperature drops rapidly.

The upper portion of the infill below and within the fibers does warm by days end. The lower portion, due to the crumb rubber having insulating value, maintains its temperature near ground temperature. A bigger factor is the cross-section design of the field and drainage below. Our recommendation is that a resilient drainage pad, that provides insulating capacity, sit below the carpet. Any potential warming of the surface during summer is prevented from going more than an inch or so into the surface by this insulating surface. Below that is typically either a subsurface detention of a combination or detention and infiltration.

Rainfall events of 0.5 inch or less produce almost no surface runoff from synthetic turf fields. This is due to rain volume filling voids in the infill material. As this water passes through this medium it warms. After passing through the turf, rainwater enters the piping network and subsurface detention system, where it will be cooled by drainage stone which will be at a ground temperature of approximately 70°F. The mass of the drainage stone is far higher than that of rainwater and results in a cooling effect. By the time it leaves the subsurface system, the water temperature will be generally equal to the ground temperature at 3 feet below grade. Because of this the system will not result in an increase in water temperatures released into stormwater drainage systems.

Conclusions:

Infill synthetic turf playing fields do get very hot during the summer months, but this material does not result in a localized heat island effect. The combination of the fiber's small mass, low heat capacity and very low albedo, create conditions in the TUF3D model that actually result in a very slight decrease in the energy required to cool buildings during the evenings. From a water quality perspective, again the fiber's small mass, low heat capacity, and very low albedo limit the potential for heat buildup in surfaces that would cause detrimental water temperatures and downstream water quality.

Still, it is strongly recommended that field users consider surface temperatures when scheduling play on the surface during summer months. Providing shade shelters, water for hydration, and possible misting stations should be standard practice. Not scheduling use during midday is also recommended. It is not recommended that water be used to cool the surface because it results in high humidity. If you desire to cool something, cool the players.

`

Conservation Commission Requests for Information #7

Re: Arlington High School Expansion SCI File #17211.00

RE: Conservation Requests June 25, 2020 Item #7 Onsite Water Capture System

We reviewed the possibility of adding an on-site water capture system to store stormwater for use in landscaping irrigation. We agree with the Commission that this would be a good element for the project, as we always look to add this sort of LID element to our designs. However, there are a number of issues with this strategy for this site, and it was originally part of the project before being determined to be cost prohibitive by the project team due to the cost implications of installation on this site versus value added.

As the Commission knows, this site is located in a highly contaminated soil area. There are very limited areas where installing an underground tank or the lines feeding it and irrigation would not impact the soil contamination and require costly remediation of excavated soils. Those areas would require significant pipe runs to the cistern, and from the cistern to any irrigated areas. The tank would also be buried extremely deeply (approx. 15 feet down) if located outside the contamination area. This cistern was determined to be extremely cost prohibitive early in the MSBA design process.

P:\Projects\2017\17211.00 Arlington HS, 869 Mass Ave (Civil)\Documents\Permiting\Conservation Commission\NOI\Con Com Additional Information\Item#7 Onsite Water Capture for Landscaping.doc

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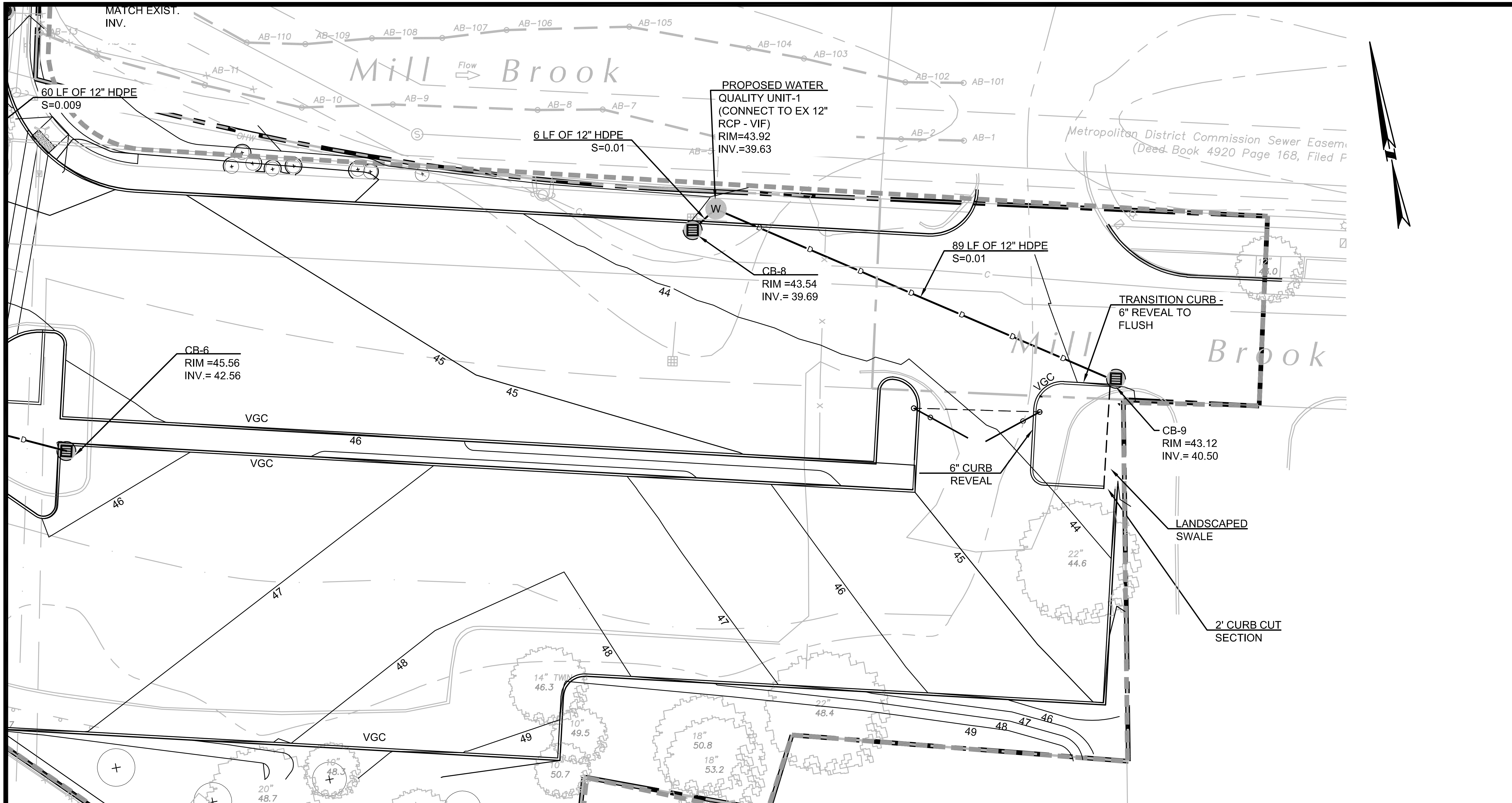

LEGEND:

VGC	PROPOSED VERTICAL GRANITE CURB
D	PROPOSED STORM DRAINAGE LINE
	PROPOSED CATCH BASIN
W	WATER QUALITY UNIT

ARLINGTON CONSERVATION COMMISSION COMMENT #6 & #9

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Conservation Commission Requests for Information #6 & 9

Re: Arlington High School Expansion SCI File #17211.00

RE: Conservation Requests June 25, 2020

We reviewed the possibility of removing curbing in the eastern parking area for stormwater management as requested, and our findings are provided within this narrative. A sketch has been provided with this narrative to show the proposed strategy to meet the request to the maximum extent practicable, pursuant to the discussion below. In summary, we can remove curbing to provide overland flow through a landscape area prior to stormwater entering the deep sump catch basins associated with the proposed stormwater management system.

There are several concerns that removal of the curbing between the south and north portions of the east parking area provides from a safety, aesthetic, and engineering perspective. First and foremost, the island itself has steep slopes, with areas having up to 3:1 landscape slopes across a large portion of the island, that would make any treatment infeasible. Curbing provides a useful barrier for vehicles parking in the spaces on the upper side of the island to keep them from rolling into that slope.

From an engineering perspective, a key portion of the stormwater design for the site includes utilization of an underground stormwater infiltration system, which provides the site with groundwater recharge and water quality treatment in accordance with the requirements of the Massachusetts Stormwater Handbook. If this curbing were to be removed, given the grades in the lower portion of the parking area, a large portion of the tributary area to that underground system that is captured in the gutter on the south side of the parking area and conveyed to the underground system would be lost, and therefore provide less water quality treatment and recharge to groundwater of the parking area. In order to meet the requirements, additional proprietary water quality treatment units would be necessary, which incur additional costs and do not provide the required recharge to groundwater.

Therefore, we are proposing to utilize the landscape island on the far east side of the parking area to send stormwater flows overland through the landscaping prior to discharging to the proposed water quality unit as shown in the sketch provided.

P:\Projects\2017\17211.00 Arlington HS, 869 Mass Ave (Civil)\Documents\Item#6 Curb Removal in East Parking Area

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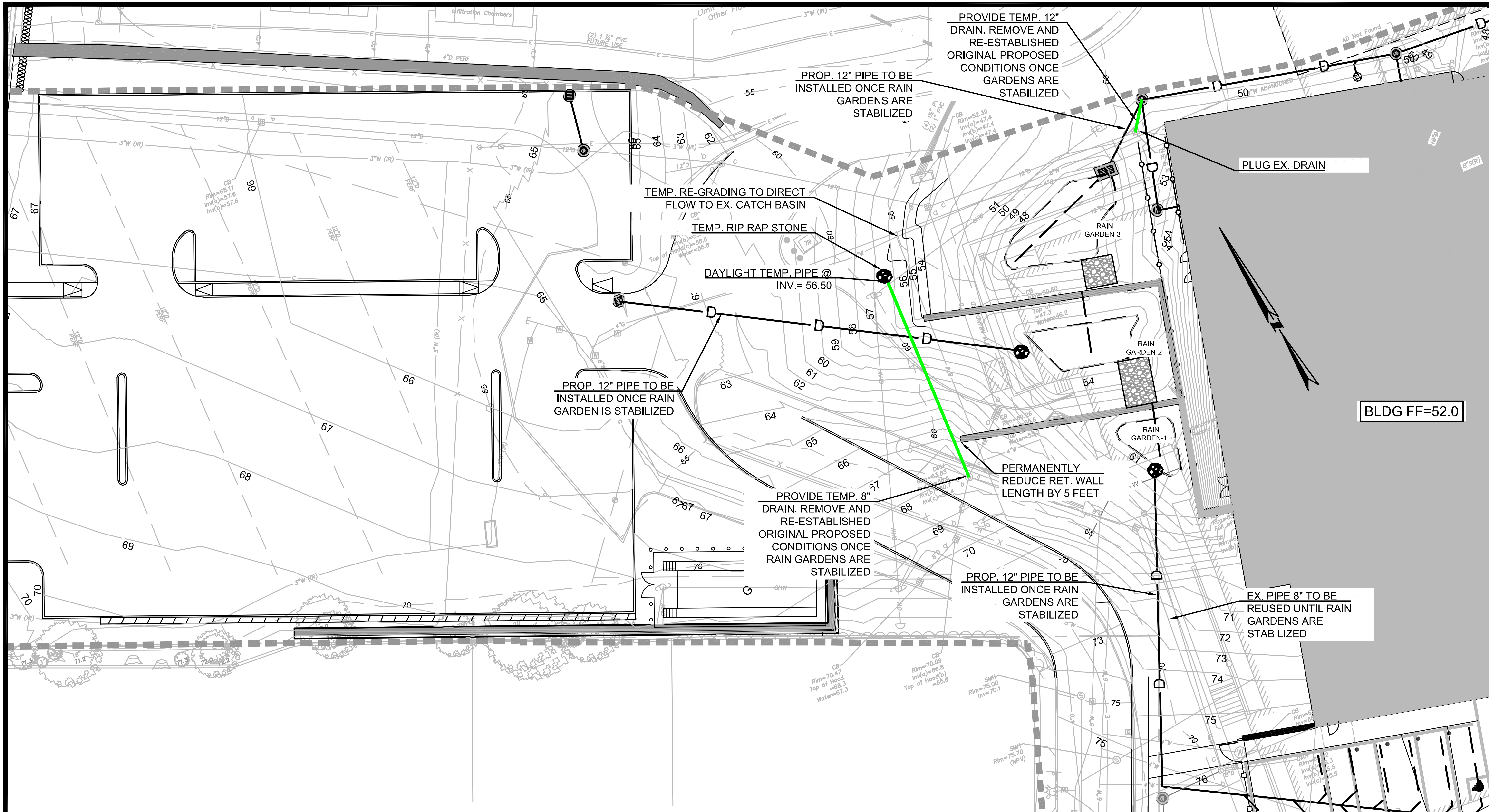

CONSERVATION COMMISSION COMMENT #10

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ARLINGTON HIGH SCHOOL
RAIN GARDEN DESIGN NARRATIVE

Introduction

This narrative is provided at the request of the Arlington Conservation Commission to clearly explain the design intent and value of the proposed Rain Gardens as part of the stormwater management system for the proposed Arlington High School construction project. As these rain gardens are not able to infiltrate into the underlying soils due to issues with ground contamination in the areas proposed, this narrative seeks to explain how the system will function to provide a valuable improvement to the water quality treatment of the surrounding area. This also promotes climate change resiliency per the Arlington bylaws.

Rain Garden Definition

The following language is provided from the Massachusetts Stormwater Handbook (Volume 2; Chapter 2; Page 23) which defines Rain Gardens and Bioretention Areas. The two terms bioretention area and rain garden are synonymous, and the type of system proposed has been bolded in the passage below:

"Bioretention is a technique that uses soils, plants, and microbes to treat stormwater before it is infiltrated and/or discharged. Bioretention cells are shallow depressions filled with sandy soil topped with a thick layer of mulch and planted with dense native vegetation. Stormwater runoff is directed into the cell via piped or sheet flow. The runoff percolates through the soil media that acts as a filter. There are two types of bioretention cells: **<u>those that are designated solely as an organic filter filtering bioretention areas</u>** and those configured to recharge groundwater in addition to acting as a filter exfiltrating bioretention areas**<u>. A filtering bioretention area includes an impermeable liner and underdrain that intercepts the runoff before it reaches the water table so that it may be conveyed to a discharge outlet, other best management practices or the municipal storm drain system.</u>**"

Benefits of Rain Gardens

Rain gardens are very valuable stormwater Best Management Practices (BMPs) because of the water quality treatment that they provide. The Massachusetts Stormwater Management Handbook specifies that Rain Gardens (whether exfiltrating into the ground or lined) provide 90% Total Suspended Solids Removal (TSS) with adequate pretreatment. We provide pretreatment via deep sump catch basins for all flows to the proposed Rain Garden system. This makes Rain Garden a very desireable BMP to use wherever space allows. For example, an infiltration basin only receives 80% TSS removal, 10% less than the Rain Garden equivalent.

Unlike typical infiltration systems, Rain Gardens also provide pollutant removal beyond suspended solids. Per the Massachusetts Stormwater Handbook, Rain Gardens remov 30-50% of total nitrogen load to the system, 30-90% total phosphorus, and 40-90% of other metals such as copper, lead, zinc, and cadmium. This is a great addition to an already robust design to increase the water quality of the flows from the proposed stormwater system associated with the Arlington High School project. As mentioned previously, the rain gardens also promote climate change resiliency and evapotranspiration.

Rain Garden System Design

Rain Gardens are intended to hold a small amount of stormwater for filtration, with an overflow provided for larger stormwater events where the storage of the garden is exceeded by the inflow of stormwater. The filter is provided via a series of layers of natural material, with an underdrain provided at the bottom of a lined Rain Garden system to convey the filtered stormwater to the stormwater management system. The filter consists of two (2) to three (3) inches of mulch on the ground surface with plantings, with between two (2) and four (4) feet of planting soil underneath. The bottom layer consists of eight (8) inches of gravel across the footprint of the Rain Garden which also acts as the bedding for the underdrain. For a lined system such as the one designed for this project, the liner will wrap the entire filter area on the bottom and sides to prevent exfiltration of stormwater into the ground. The mulch and soil specifications are provided within the Massachusetts Stormwater Handbook, and are contained within the project specifications to ensure that the requirements for the system per the handbook are met.

Plantings proposed within the Rain Gardens are those defined in the "Plant Species Suitable For Use in Bioretention – Herbaceous Species" list within the Massachusetts Stormwater Handbook. The plantings chosen, shown on the landscape plans for the project, are all native species. A list of the plantings used, highlighted from the list in the Massachusetts Stormwater Handbook is appended to this narrative.

Stormwater Routing

The Rain Garden system design for the Arlington High School project consists of a series of three (3) cascading Rain Gardens separated by retaining walls moving down the slope on the west side of the proposed building as shown on the Stormwater Management Plans. Per the definition provided above, these Rain Gardens are each lined with impermeable liner to prevent exfiltration of stormwater into the ground which is not suitable for infiltration. An underdrain pipe is provided for each Rain Garden to convey flows after they have filtered through the mulch and soil media. These underdrain pipes for RG-1 and RG-2 discharge to the Rain Garden downstream (RG-2 and RG-3 respectively). The top two Rain Gardens (RG-1 and RG-2) have a weir wall on their north side. This is intended to allow stormwater flows to travel over the portion of the wall adjacent to the Rain Garden in larger storm events to prevent overflow of the system. Stormwater flowing over the weir wall is intended to drop onto the rip rap pad below in the Rain Garden directly downstream of RG-1 and RG-2 (RG-2 and RG-3 respectively). RG-3 includes an outlet control structure with a series of orifices to allow for stormwater to discharge from the Rain Garden when the storage provided is exceeded without overflowing into the surrounding areas in addition to the underdrain piping for the filtered water. See the attached sketch plan for reference on the location of the various elements of the Rain Garden system graphically as described above.

Rain Garden Data from the Massachusetts Stormwater Handbook

Below is an exerpt from the Massachusetts Stormwater Handbook giving metrics for Rain Garden BMPs.

Standard	Description
2 - Peak Flow	N/A
3 - Recharge	An exfiltrating bioretention area provides groundwater recharge.
4 - TSS Removal	90% TSS removal credit with adequate pretreatment
5 - Higher Pollutant Loading	Can be used for certain land uses with higher potential pollutant loads if lined and sealed until adequate pretreatment is provided. Adequate pretreatment must include 44% TSS removal prior to infiltration. For land uses that have the potential to generate runoff with high concentrations of oil and grease such as high intensity use parking lots and gas stations, adequate pretreatment may also include an oil grit separator, sand filter or equivalent. In lieu of an oil grit separator or sand filter, a filtering bioretention area also may be used as a pretreatment device for infiltration practices exfiltrating runoff from land uses with a potential to generate runoff with high concentrations of oil and grease.
6 - Discharges near or to Critical Areas	Good option for discharges near cold-water fisheries. Should not be used near bathing beaches and shellfish growing areas.
7 - Redevelopment	Suitable with appropriate pretreatment

Pollutant Removal Efficiencies

• Total Suspended Solids (TSS)	90% with vegetated filter strip or equivalent
• Total Nitrogen	30% to 50% if soil media at least 30 inches
• Total Phosphorus	30% to 90%
• Metals (copper, lead, zinc, cadmium)	40% to 90%
• Pathogens (coliform, e coli)	Insufficient data

Rain Garden Maintenance Requirements

Inspection and Maintenance of Rain Gardens shall be conducted per the Bioretention Maintenance Schedule provided below from the Massachusetts Stormwater Handbook:

Activity	Frequency
Inspect and remove trash	Monthly
Mow	2 to 12 times per year
Mulch	Annually
Fertilize	Annually
Remove dead vegetation	Annually
Prune	Annually

It should be noted that the Massachusetts Stormwater Handbook requires that rain gardens cannot have stormwater flows directed to them until the tributary area is entirely stabilized to prevent sedimentation of the rain garden. The plantings in the rain garden are species that are intended to be inundated by stormwater with each rain event, so once the plantings are in place there should be no issues with establishment, even with stormwater being directed to the rain garden.

H M
F H

MEMORANDUM

OFFICE. (617) 492 2200
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130 Bishop Allen Drive
Cambridge, MA 02139

hmfh.com

date: 06.23.2020

from: HMFH Architects on behalf of the Town/School District

to: Arlington Conservation Commission

re: Arlington High School Stormwater and Rain Garden Maintenance

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QUESTION:
The O&M Plan for Stormwater post-construction identifies the responsibilities of the owner re: inspection and maintenance of stormwater controls, the outlets, and the rain garden. In terms of the “Owner” I think clarification should be provided how the “Owner” will discharge these responsibilities.

RESPONSE:
Maintenance would be accomplished through a combination of resources.

We would rely on Public Works for their street sweeper and Vactor truck. I envision Town Facilities would manage landscaping-efforts related to on-site vegetation, perhaps in conjunction with the appropriate school club or class. And finally, for underground storage chambers and WQUs, we would seek assistance from 3rd party contractor.

j:\arlhs-408417\c02-regs\06-concom\stormwater rain garden maintenance.docx

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CROSBY | SCHLESSINGER | SMALLRIDGE llc

July 1, 2020

Arlington Conservation Commission
Removal of Invasive Plant Species.

To whom it may concern,

In coordination with the landscape services provided to the Town of Arlington as part of the design and construction of the Arlington High School, Crosby Schlessinger Smallridge, LLC will work with the Arlington Conservation Commission to provide specifications for the project contractor to remove invasive species along the Mill Brook stream bank (adjacent to the proposed parking lot and access drive) within the limits of work for this project. This work will include one site visit to identify invasive plant species to be removed, photo documentation and a draft specification submitted to the Arlington Conservation Commission for review. Prior to the visit, we are assuming that the Conservation Commission will provide us with any information regarding acceptable invasive plant removal treatments so that our work will be in keeping with the practices in Arlington. As invasive plant removal is an ongoing maintenance issue – it will be important to understand the Conservation Commission's expectations with regard to the contractor responsibilities so that that can be stated in the project specifications.

SITE VISIT NOTES

Susan Chapnick, Chair, Chuck Tirone, Co-Chair, Nathaniel Stevens, Commissioner, Pam Heidell, Commissioner, Dave Kaplan, Commissioner, and Cathy Garnett, Assistant Commissioner of the Arlington Conservation Commission performed a site visit at 869 Massachusetts Avenue, on 6/12/2020, at 8:30AM. We were accompanied on site by Steve Garvin, P.E., Applicant's representative, and several members of Consigli Construction including Cam Patch, Assistant Site Superintendent.

General Observations:

The site is secure with the main entrance on Mass Ave, where we filled out electronic forms for COVID19 emergency regulations. Signage at the site entrance clearly showed the MassDEP File No. Construction was on-going during our site visit for portions of the site already permitted and/or outside of the Commission's jurisdictional areas.

Observations on Jurisdictional Areas Observed:

We walked on Mass Ave and Mill Street to the Parking lot entrance at Mill Brook Drive and along Mill Brook at the East end of the site to see the eastern portion of the site within Commission's jurisdiction. Proper sedimentation/erosion controls were observed in this area, including silt fence /stacked bales and silt sacks on storm drains. We discussed the proposed sidewalk, which will be pushed back to approximately 15 feet and pitched away from the brook and discussed invasives along Mill Brook. The parking spaces also will be pushed back, with this new sidewalk between parking spaces and Mill Brook.

C. Tirone asked if the parking lot curbing for the center island could be removed and the flowerbeds could be designed with an underdrain to promote sheet flow infiltration in that area. S. Gavin said that they would look into it but the elevations for the parking lot are lower than the proposed location for the "storm scepter" located upgradient and closer to the high school. C. Tirone asked to look into a separate "storm scepter" closer to the property line parking lot entrance were the elevations would benefit the design. S. Garvin said they would look into it further.

C. Tirone asked about the vegetation along Mill Brook. S. Garvin said they are not proposing any work in this (Bank) area. C. Tirone said it was our one opportunity to improve this area and during this project and we would not have another opportunity to make any improvements. S. Garvin said they would look into it.

We discussed working with the Commission to discuss options to:

- improve the vegetation/habitat along Mill Brook such as removal of invasive species and some new plantings (the applicant was amenable to suggestions from the Commission) and
- potential to improve the design of the proposed "storm scepter" in the adjacent parking area.

We walked along the back of AHS towards the proposed Artificial Turf field, which is currently a natural grass field. Along the way, C. Tirone noticed three storm drains that were not protected (see photos). These storm drains were not in the Commission's jurisdictional areas; however, surface water flow from these drains would ultimately end up in Mill Brook.

The current natural turf field that is proposed for Artificial Turf abuts the existing Artificial Turf field, which will not be altered. We discussed where the 100 foot Buffer to Mill Brook / AURA was located – approximately half-way to the current pitcher's mound on the existing natural turf field. S. Chapnick made the observation to S. Garvin that the proposed Artificial Turf field approximately doubles the amount of plastic surface / Artificial Turf from existing conditions, which he agreed was correct. S. Garvin also confirmed that based on the proposed project, the Artificial Turf field will abut a parking lot. S. Chapnick observed that the Artificial Turf fields served no habitat function and were, essentially, similar to under-drained porous pavement parking lots.

The Commission members had questions about where the rain garden was located, how it would be constructed in a low spot near a building of the AHS campus on one side and parking lot on the other side of it, and the timing of its being put online. We discussed working with the Commission to:

- improve the design of the rain gardens to allow for heavy rainfall to by-pass the rain garden area until the plantings are established
- provide metrics on rain garden detention basin / treatment
- maintenance / resilience of rain garden

P. Heidell asked about green roofs as a mitigation strategy for changing natural turf to Artificial turf. S. Garvin explained that the AHS planners worked with Sustainable Arlington on some measures and the buildings will be LEED certified for energy efficiency. S. Garvin said they may have also looked at green roofs. S. Garvin said that Photovoltaics are planned over the parking in this section of the site in the future. He also mentioned that the geothermal energy system was dropped from the design after it was deemed impractical due in part to the barrier under the surface capping hazardous materials. S. Chapnick asked for the contact information for the Sustainable Arlington group that interfaced with the AHS project team.

Mystic River
WATERSHED ASSOCIATION

Conservation Agent Emily Sullivan
Department of Planning & Community Development
Town of Arlington
730 Mass Ave. Annex
Arlington, MA 02476

Re: Arlington High School Notice of Intent, File #091-0323

July 2, 2020

Dear Conservation Agent Sullivan:

Thank you for the opportunity to comment on this redevelopment project, whose consequences will be important to the future hydrology of the Mystic River watershed and to our community.

The Mystic River Watershed Association (MyRWA) was founded in 1972 to protect and restore the river, its tributaries, and watershed lands, spanning 21 municipalities from Reading through Revere, for the benefit of present and future generations. As part of this work, our organization has a powerful focus on climate resiliency and the acute risks of increasing flooding and other impacts as climate disruption manifests on our communities. Our organization is headquartered in Arlington, just a few minutes' walk from the site of the high school.

We applaud the applicant for many aspects of this development proposal which seem, upon our review of the Notice of Intent, thoughtfully designed and beneficial to our community. With respect to environmental impact, these positive elements of the proposal include:

- Attention to erosion and sediment control during construction.
- Intent to meet both state and local low impact development BMPs including use of rain gardens and pre-treating stormwater with water quality units.
- Improvements to the riverfront area including wildlife friendly plantings and "low mow" grasses.
- Steps taken to meet the MA Department of Environmental Protection's 2008 stormwater standards such as pre-treatment of discharge, avoiding net increase in discharge rates (despite introduction of some new impervious surface), and removal of total suspended solids (TSS) via catch basins and other features.

However, we have significant concerns that the development as proposed needs further attention to the accelerating risk of flooding due to climate disruption and to the potential environmental damage from runoff from the artificial turf field.

Planning for the anticipated impacts of climate disruption

We urge Arlington to require the developer to demonstrate that the new site will not be impacted by flooding in the 500 year floodplain (Zone X) and/or that appropriate mitigations will be taken for this scenario.

We recognize that planning for mitigation against Zone X flooding events goes beyond the regulatory requirements under [310 CMR 10.02(2)(b)3] for Bordering Land Subject to Flooding, but we believe this step is necessary to protect into the future the substantial investment made by the Town in the school redevelopment. The proponent's application states with respect to the Mill Brook culvert: "Historically this culvert has been shown to be undersized and has caused flooding and floor buckling within the basement of the High School." Such a recurring cost and disruption from flooding is unacceptable and unnecessary for new construction in 2020 and can be avoided with foresight into the changing nature of our regional climate.

In partnership between MyRWA, the Town of Arlington, and many other stakeholders in our watershed, the Resilient Mystic Collaborative has gathered ample data and scientific projections about the impacts climate disruption will have on Arlington and other lands in our watershed[1]. This evidence makes clear that our region will be subject to more and more extreme precipitation events in the coming decades that will increase the frequency of "500 year storm events" (as established under prior climate conditions) and challenge the capacity of floodwater storage systems. The 2016 Climate Ready Boston report, for example, reports a Boston Water and Sewer Commission projection of a 15% increase in the precipitation from the 10-year, 24 hr design storm over the next 4 decades[2].

The NOI filing focuses on the 100yr flood plain (Zone AE), which does not extend to the footprint of the proposed development. However, we believe the accelerating risk of flooding due to climate disruption makes the 500 yr floodplain (Zone X) a more relevant basis for planning. According to Figure 3 of the "Wetland Delineation Memo" submitted with the NOI, all or a large fraction of the project site falls within Zone X.

In the proponent's Stormwater Report, the developers quote their Flood Impact Study which confines the Zone X flood risk to within the banks of the Mill Brook: "after a field survey of elevations present at the site, we have concluded that the flood elevations shown on the FEMA mapping are held within the banks of the Mill Brook and do not encroach on the site." That claim is difficult to reconcile with the historical evidence cited elsewhere of impacts on the existing high school's basement.

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[1] https://resilient.mysticriver.org/climate-data
[2] https://www.boston.gov/sites/default/files/document-file-12-2016/brag_report_summary.pdf

Mitigating the stormwater impacts of artificial turf

The design of the turf fields should prioritize the health of people and the environment. Artificial turf fields built with crumb rubber fill are known to leach toxic levels of heavy metals, particularly zinc, that pose a significant risk to aquatic life in nearby surface waters after rain events, according to a study conducted by the Connecticut Department of Environmental Protection in 2010[3]. While we appreciated the supplemental narrative on artificial turn provided by the proponent and its discussion of the potential for drinking water contamination, we strongly advocate for the implementation of stormwater best management practices (BMPs) specifically designed to mitigate the effects of heavy metal contamination that would endanger fish and other aquatic species as well.

Given that rubber fill will contribute to the heat island effect, the best alternative would be to use an organic infill such as GreenPlay[4], PureFill[5], or Geofill, which consists of 90% crushed coconut husks and 10% cork and was recently installed at Simmons College's Daly Field on the banks of the Charles River.

The proponents plan for an existing compensatory flood storage area to be replaced with a larger capacity within the stone of the turf fields. **We recommend that the proponents be required to demonstrate that this increased storage capacity, together with other measures made in the development, will be sufficient to mitigate the impacts of a 500 yr flood event at the site and that the potential for stormwater contamination from the artificial turf will also be mitigated.**

Thank you again for the opportunity to comment on this important development.

Sincerely,

Patrick Herron
Executive Director, Mystic River Watershed Association

P. S. While not covered in the Notice of Intent, we want to draw attention to an issue at Arlington High School that has impacted Mill Brook. On a regular basis, sports teams have held car washes for the purpose of fundraising. These car washing events, while laudable in supporting youth athletics, result in the direct discharge of detergents, grit and associated pollutants to Mill Brook. We would request that the proponent of the project offer a modification that allows for these events but offers an opportunity to discharge to the sewer system.

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[3]http://www.ct.gov/deep/cwp/view.asp?A=2690&Q=463624
[4]http://greenplayusa.com/
[5]http://www.fieldturf.com/it/purefill

ARLINGTON HIGH SCHOOL BUILDLING COMMITTEE

July 9, 2020

Arlington Conservation Commission
Department of Planning and Community Development
Town of Arlington
730 Massachusetts Avenue Annex
Arlington, MA 02476

Dear Commissioners:

Thank you for the opportunity to provide comment prior to your upcoming vote on the Arlington High School Building project.

We understand that members of the Commission have raised concerns about the additional artificial turf fields at Arlington High School and the potential effects on Mill Brook. Our design team has answered your questions and provided supplemental documentation, and we are committed to responding to any future concerns you have.

The purpose of this letter is to give you an overview of the process by which our community came together to support and approve the Arlington High School Building project, explain the committee's support for the artificial turf fields, and share information about how we featured the artificial surfaces in our public education campaign.

Arlington High School Principal Dr. Matthew Janger and Superintendent Dr. Kathleen Bodie will present a separate letter detailing the educational value of the artificial turf surfaces, and Dr. Janger will be at your meeting to answer questions.

Since we were formed in 2016, the Arlington High School Building Committee has worked to create a very energy efficient and green building, which will operate without the direct use of fossil fuels while generating significant amounts of solar electricity on site. Through a highly public process, we built a broad coalition of community members committed to doing what was best for students, including people who care about the arts, academics, athletics, and the environment.

The Arlington High School Building Committee has engaged in a very public, four-year process of community input, which included presentations to all Commissions and Committees in Town, including

the Conservation Commission. We held multiple public hearings and made a presentation to Town Meeting, which voted in favor of the project. Ultimately, we campaigned throughout the community in the spring of 2019, educating the public about the value of the project, answering questions about costs, and providing detailed specifics on the design of the project. Last June, 76% of the Town's voters approved the building project.

Prior to the town-wide vote, the Building Committee voted to include artificial turf in the final design we presented to voters because our educational leaders believed this surface was in the best interest of our students. The turf allows for longer outdoor athletic seasons, provides more space for outdoor gym classes required of all students, results in fewer injuries, and reduces the number of cancelations of games and practices.

Additionally, the Building Committee voted for the turf fields because town leaders believed placing multiple artificial surfaces at Arlington High School benefits the broader community, which needs places for recreation and athletics. The Town's youth sports program will benefit from having access to additional turf fields that close less often in inclement weather than grass fields.

Throughout the process, we explained that the building design included additional artificial turf fields. The artificial turf fields were mentioned clearly in the 2019 campaign, we answered questions about turf surfaces at multiple forums, and the field plan was a motivator for some voters to support the project. One of the Boards we presented to – the Arlington Recreation Commission – asked for a guarantee that the AHS Building Committee would not remove the artificial turf should we need to reduce costs in order to meet the budget approved by the voters.

The high school site is compact and complicated. Reducing the size of the new artificial turf surfaces so that they fall outside of the jurisdiction of the Conversation Commission, as some have suggested, would make the space too small to be a varsity baseball field, and result in a potential Title IX violation. (Title IX prohibits discrimination on the basis of sex in education programs and activities). Eliminating one of the artificial fields, the one closest to Mill Brook, also could subject the town to Title IX litigation because one gender would have more practice and playing time than the other.

The new Arlington High School, including the artificial turf fields, enjoys widespread support in our community thanks to a highly collaborative effort by a broad and diverse coalition of residents.

We have great respect for the work of the Conservation Commission, and our design team has worked tirelessly to answer every question Commissioners have raised. We hope the information presented has been helpful. As our design team has indicated, the Arlington High School Building Committee is committed to selecting artificial turf that will last and minimize any potential harm to the environment.

We are happy to answer any additional questions you have, and we respectfully request that the Commission unanimously support the current design of the Arlington High School Building project.

Sincerely,

Jeff Thielman

Jeff Thielman
Chair, Arlington High School Building Committee

Cost Comparison Artificial Turf vs. Natural Turf
Life Cycle Evaluation for 25 years

Turf Type	Initial Cost[1]	Hours of Use per year[1]	Replacement Life years[1]	Yearly Sodding Cost per hour[1]	Useful Life Cost per hour[2]	Effect Maintenance per hour of Use[1]	Net Cost[3]	Net Cost for 25 years
Natural	$600,000.00	1040	25	$19.23	$23.08	$43.20	$85.51	$85.51
Artificial (Infill Synthetic)	$1,200,000.00	3120	10	$0	$38.46	$9.60	$48.06	$100.92
Est. replacement field[4]	$600,000.00	3120	10	$0	$19.23	$9.60	$28.83	
Est. replacement field	$300,000.00	3120	5	$0	$19.23	$4.80	$24.03	
Disposal Costs[5]	2 x $?							

[1]Source = John J. Amato White Paper "Infill Synthetic Turf, Synthetic Turf Use and Life Cycle Evaluation" 2020
[2]Calculation = Initial cost/(hours use/yr x replacement life yr)
[3]Calculation = Yearly Sodding Cost + Useful Life Cost/h + Effect Maintenance /h Use
[4]Estimated replacement field cost as 50% of initial cost; estimated additional 5 years as 50% of the first replacement cost. Sharon Conservation Commission estimated replacement cost of Artificial Turf field as 50% of the initial costs but replacement life was 8 y.
[5]Disposal costs of the Artificial Turf, required twice over a 25-year life cycle time-frame, is unknown

Sports Turf Alternatives Assessment: Preliminary Results
COST ANALYSIS

Massachusetts Toxics Use Reduction Institute
September 2016

Introduction

The Massachusetts Toxics Use Reduction Institute (TURI) conducts alternatives assessments as part of its overall mission to help Massachusetts companies, communities, and municipalities identify and implement toxics use reduction options that will provide safer solutions to the use of toxic chemicals.

TURI has received numerous requests for information about artificial turf fields as an alternative to natural grass fields. In response, TURI is developing an alternatives assessment for sports turf. Preliminary sections of the assessment are being published in the order in which they are developed.

The section presented here covers information on costs (installation, maintenance, replacement and disposal) associated with synthetic and natural turf options. Information for this section has been drawn from industry publications, articles in the press, and personal communications from municipal grounds managers. This chapter may be updated over time as new information becomes available.

Cost Analysis

In analyzing the costs of artificial vs. natural grass systems, it is important to consider full life-cycle costs, including installation, maintenance, and disposal/replacement. This section provides information on each of these categories of cost, comparing costs for artificial turf fields with those for natural grass. Information is also presented on the relative costs of conventional versus the organic management of natural grass.

Costs vary substantially depending on the type of field, the level of maintenance, and other factors. In general, however, artificial turf fields have a higher life-cycle cost than natural grass fields. Once established, organic management of natural grass can be even more cost effective than conventional management of natural grass.

Installation

Installation costs depend on a variety of factors, including the type of field chosen and the dimensions of the field. Cost estimates are shown below for two possible field sizes: 85,000 square feet or 65,625 square feet (based on a calculation of a football field with a play area of 360x160 feet plus a 15-foot extension on each dimension).

Some sources provide total estimated costs, while others provide estimated costs per square foot. The Turfgrass Resource Center (TRC) is a project of Turfgrass Producers International, an

industry association that promotes the use of natural grass. The SportsTurf Managers Association (STMA) is an association of sports field managers. The TRC has developed total estimated costs, while the STMA has estimated costs per square foot. In Table 1, below, we have converted all estimates to total costs per field for two possible field sizes.

As shown in the table, installation costs for an 85,000 square foot natural grass field can range from $50,000 to $600,000, depending on the complexity of the site work, drainage and caps. Costs for a synthetic turf field of the same size can range from under $400,000 to approximately $1 million.

The total budget of a project to install a synthetic field may include a variety of additional activities that are not directly associated with the synthetic turf, such as other landscaping, paving or equipment. Variation in estimates may depend in part on the range of elements that are included in the cost calculation. Some estimates may focus on field installation only, while other estimates may include items beyond basic field installation, such as additional water systems and site work.

<table>
<tr><th colspan="5">Table 1: Installation Costs*</th></tr>
<tr><th>Field size (square feet)</th><th>85,000 (TRC)</th><th>85,000 (STMA)</th><th>65,625 (STMA)</th><th>undefined (Fresenburg)</th></tr>
<tr><td colspan="5">Natural grass</td></tr>
<tr><td>Native soils</td><td rowspan="2">$50,000-$150,000</td><td>$106,000-$213,000</td><td>$82,000-$164,000</td><td></td></tr>
<tr><td>On-site native soils (no added top soil or sod)</td><td>$51,000-$77,000</td><td>$39,000-$59,000</td><td>$0</td></tr>
<tr><td>Sand and drainage</td><td>$250,000-$350,000</td><td>$361,000-$425,000</td><td>$279,000-$328,000</td><td></td></tr>
<tr><td>Sand cap</td><td></td><td>$221,000-$327,000</td><td>$171,000-$253,000</td><td>$300,000</td></tr>
<tr><td>Sand-based mesh element</td><td>$450,000-$600,000</td><td></td><td></td><td></td></tr>
<tr><td>“Pure sand based water-contained sub-surface systems”**</td><td>$500,000-$600,000</td><td></td><td></td><td></td></tr>
<tr><td colspan="5">Synthetic turf</td></tr>
<tr><td></td><td>$850,000-$1,000,000</td><td>$383,000-$871,000</td><td>$295,000-$673,000</td><td>$600,000-$1,000,000</td></tr>
</table>

Sources: Turfgrass Resource Center (TRC). (no date.) “Natural Grass and Artificial Turf: Separating Myths and Facts.” Available at http://www.nsgao.com/images/Natural-Grass-and-Artificial-Turf_booklet.pdf. Sports Turf Managers’ Association (STMA). (no date.) “A guide to Synthetic and Natural Turfgrass for Sports Fields, 3rd edition. Available at http://www.stma.org/sites/stma/files/STMA_Bulletins/STMA%20Syn%20and%20Nat%20Guide%203rd%20edition%20FINAL.pdf. Brad Fresenburg. “More Answers to Questions about Synthetic Fields – Safety and Cost Comparison”, Turfgrass Specialist & Extension Associate, University of Missouri. PowerPoint slides obtained via email December 2015.

* Rounded to three significant digits.

** “This is a new type of natural grass field that requires less than 50 percent of the water of a normal sand based field.” (Turfgrass Resource Center)

Table 2 shows the budget for a 117,810 square foot synthetic field installation project for the town of Natick, Massachusetts which took place in 2015. The field includes a 2.25 acre soccer field, about 0.5 acres of surrounds, and another one acre field. The field is composed of crumb

rubber infill with no sand mixed in. As shown in the table, the project budget includes core items such as land clearing, drainage, earthwork, and field surfacing; it also includes other, related items such as paving and site furnishings. The total project cost was over $1.2 million (Goodhind 2016).

Table 2: Natick Town Field: Synthetic Turf Installation, 2015	
Item	*Cost*
General Conditions	$24,000
Mobilization	$59,000
Land Clearing	$41,200
Drainage	$100,500
Earthwork	$131,000
Fencing	$43,500
Landscaping	$38,500
Masonry	$75,000
Field Surfacing	$556,000
Paving (sidewalks)	$46,000
Site Furnishings/Athletic Equipment	$6,300
TOTAL:	**$1,223,829**
Source: Art Goodhind, Land Facilities & Natural Resources Supervisor, Town of Natick (personal email communication, April 11, 2016. Field size: 117,810 square feet.	

Cost of Synthetic Infills by Type

There are many possible synthetic infill options, some more readily available than others. The information in Table 3 is drawn from a general cost and availability comparison on various synthetic infills (Gale Associates 2015). As shown in the table, according to the Gale Associates analysis, crumb rubber, silica sand, and coated crumb rubber are readily available, while the other options have limited availability.

Table 3: Gale Associates Infill Cost Comparisons

Infill Type	**Typical Mixture, by weight**	**Approximate cost***	**Availability****
Crumb rubber	50% sand 50% rubber	$50,000	Readily available
Silica sand	100% silica sand	+$0 net for additional sand +$130,000 (resilient pad)	Readily available
Organic (cork or coconut or rice)	10-15% organic 90-85% sand	+$180,000 (materials) +$130,000 (resilient pad) +$15,000 (irrigation)	Limited
Coated crumb rubber	50% sand 50% coated rubber	+$220,000 (materials)	Readily available
ethylene propylene diene monomer (EPDM)	50% sand 50% EPDM	+$360,000 (materials)	Limited

thermoplastic elastomer (TPE)	50% sand 50% TPE	+$360,000 (materials) +$130,000 (resilient pad)	Limited
Coated sand	100% coated silica sand particles	+$150,000 to $250,000 (materials) +$130,000 (resilient pad)	Limited
Nike Grind	50% sand 50% Nike Grind	+$130,000 (resilient pad)	Very limited
Source: Gale Associates. 2015. “Alternative Infills for Synthetic Turf.” Table prepared by Gale Associates, March 17, 2015. Available at http://www.galeassociates.org/wp-content/uploads/2015/03/Alternative-Infills-for-Synthetic-Turf.pdf, viewed December 11, 2015. * “Costs are generalized approximations. Costs are net addition to cost of a typical sand/SBR turf infill system. Actual costs will vary based on depth of infill/turf depth, and type of resilient pad used. Market costs can vary greatly due to materials demand and availability.” Costs shown with a “+” are added to a base cost of $50,000 per field. ** “May become more or less available as demand and popularity fluctuates. Cost fluctuates with availability.”			

Information about the cost of various alternatives is included in several press stories in 2015.

- The town of Marlborough, Massachusetts chose to look at alternatives to standard crumb rubber for their 102,000 SF field. A consultant presented three alternative materials: a rubber that receives an ultraviolet coating to reduce the release of chemicals, a plastic compound and an “organic infill” made of recycled coconut fiber and sand, possibly also including cork and rice husks. It was determined that the encapsulated rubber that receives an ultraviolet coating would cost an additional $114,000 more than uncoated crumb rubber; the thermoplastic elastomer, a plastic compound, would cost an additional $229,000; and the “organic infill” would cost an additional $451,000. (Activitas 2014; Malachowski 2014).
- A California town considered an organic coconut fiber infill for a project and it was estimated to cost $1.25 per pound, nearly three times as much as the originally proposed acrylic-coated rubber crumbs (Ruiz 2015).
- A Pennsylvania town chose to move to the Nike Grind product despite spending about $350,000 more than expected on two synthetic fields (Lester 2015).

Maintenance

Maintenance of artificial turf systems can include fluffing, redistributing, and shock testing infill; periodic static control and disinfection of the materials; seam repairs and infill replacement; field line erasing and repainting; organic matter removal; and watering to lower temperatures on hot days. Maintenance of natural grass can include irrigation, mowing, fertilizing, replacing sod, and other activities. A soil and grass health assessment of the field is needed to establish an appropriate maintenance program. Maintenance of a natural field may be minimized by substituting full field replacements and seam repairs with spot sod replacements. In both systems, specialized equipment is needed. Communities shifting from natural grass to artificial turf may need to purchase new equipment for this purpose.

As noted in Table 4 below, the costs of field maintenance can vary widely. This can depend on its exact makeup, the initial condition of the field, and the standards to which it is kept.

<table>
<tr><th colspan="4">Table 4: Maintenance Costs</th></tr>
<tr><td>Material Type</td><td>Annual Maintenance – 65,625 sf field*</td><td>Annual Maintenance – undefined field size – 16-yr cost analysis with and without surface replacements**</td><td>Annual Maintenance – undefined field size***</td></tr>
<tr><td colspan="4">Natural turf fields</td></tr>
<tr><td>Natural with native soils</td><td rowspan="4">$4,000-$14,000 (materials) + 250-750 hours (labor)</td><td></td><td rowspan="4">$8,133-$48,960</td></tr>
<tr><td>Natural with on-site native soils (no added top soil or sod)</td><td>$25,000 (initial maintenance cost)
$37,287 (with 4, 8, 12, and 16 year replacement costs factored in)</td></tr>
<tr><td>Natural with sand and drainage</td><td></td></tr>
<tr><td>Natural with sand cap</td><td>$25,000 (initial maintenance cost)
$53,787 (with 4, 8, 12, and 16 year replacement costs factored in)</td></tr>
<tr><td colspan="4">Synthetic turf fields</td></tr>
<tr><td></td><td>$4,000 (materials) + appr. 300 hours (labor)</td><td>$5,000-$20,000 (initial maintenance cost)
$93,000-$136,169 (with 8 and 16 year surface replacement costs factored in)</td><td>$13,720-$39,220</td></tr>
<tr><td colspan="4">Sources:
* STMA. (no date.) “A guide to Synthetic and Natural Turfgrass for Sports Fields, 3rd edition. Available at http://www.stma.org/sites/stma/files/STMA_Bulletins/STMA%20Syn%20and%20Nat%20Guide%203rd%20edition%20FINAL.pdf
**Brad Fresenburg, “More Answers to Questions about Synthetic Fields – Safety and Cost Comparison”, Turfgrass Specialist & Extension Associate, University of Missouri. PowerPoint slides obtained via email December 2015.
***Turfgrass Resource Center. (no date.) “Natural Grass and Artificial Turf: Separating Myths and Facts.” Available at http://www.nsgao.com/images/Natural-Grass-and-Artificial-Turf_booklet.pdf.</td></tr>
</table>

The Turfgrass Resource Center provided further breakdown of their numbers noted above as shown in Table 5 below (TRC n.d. a).

Table 5: Annual Maintenance Requirements (TRC)

Synthetic Turf		Natural Grass	
Painting/paint removal (various sports)	$1,000-10,000	Painting (various sports)	$800-12,300
Top dressing/infill	$5,000	Top dressing (sand)	$0-5,400
Brushing/sweeping	$1,000-5,000	Dragging	$0-200
Disinfecting/fabric softener	$220	Fertilizers	$1,200-11,000
Carpet repairs (rips, joints)	$1,000-8,000	Pesticides	$650-6,300
Water cooling	$5,000-10,000	Aeration	$700-960
Weeding	$500-1,000	Sod replacement	$833-12,500

		Irrigation	$300-3,000
Total	**$13,720-39,220**	**Total**	**$8,133-$48,960**
Source: Turfgrass Resource Center. (no date.) "Natural Grass and Artificial Turf: Separating Myths and Facts."			

Maintenance: Equipment. Some data show that equipment for maintaining a natural grass field may be more expensive than that for a synthetic field. However, towns or schools may be more likely to already own this equipment, thereby making natural grass field maintenance equipment costs lower. Information in Table 6 was published by The Turfgrass Resource Center detailing a comparison of equipment and maintenance used for artificial turf and natural grass fields. The data is a compilation from a variety of sources that are meant to provide a starting point for entities considering which type of field to install (TRC n.d. a).

Table 6: Cost of Equipment, Supplies, and Labor (TRC)			
Synthetic Turf		**Natural Grass**	
Water (for cooling)	$6,000-35,000	Irrigation	$6,000-35,000
Sprayer for water application	$1,000-35,000	Equipment for irrigation	$3,000-31,000
Sweeper	$1,500-20,000	Mower	$13,000-69,000
Mechanical broom	$500-3,000	Fertilizer applicator	$1,000-3,000
Line painter	$500-$3,000	Line painter	$700-3,000
Groomer	$1,500-2,000	Rollers	$2,000-4,000
Cart (for towing equipment)	$7,000-16,000	Cart (for towing equipment)	$7,000-18,500
Field magnet	$500-1,000	Aerator	$3,500-17,000
Rollers	$250-2,000	Vacuum	$2,100-5,000
Top dresser	$4,500-10,000	Top dresser	$4,500-20,000
Total	**$23,250-127,000**	**Total**	**$42,800-205,500**
Source: Turfgrass Resource Center. (no date.) "Natural Grass and Artificial Turf: Separating Myths and Facts."			

Maintenance: Synthetic and Natural Turf in Marblehead. The town of Marblehead, MA maintains both synthetic turf and natural grass for playing fields. The Chairman of the Recreation and Park Commission has provided information about their costs for maintenance of the two types of fields. (Osborne 2016).

Marblehead's synthetic turf field is 65,340 square feet. As shown in Table 7 below, the town made a capital investment of between $10,000 and $14,000 for a Gator utility vehicle and $7,500 for a brusher to attach to it. The synthetic turf field is groomed by an in-house Marblehead Recreation and Parks Department staff member who spends about a half day every three weeks in the spring and fall and every four weeks in the summer. That equates to $1,000 to $1,400 in labor costs (including fringe).

The town received a bid for disinfection application two times per year, for a total annual disinfection cost of $6,000. The chemical disinfection product was determined to contain several potential human carcinogens. A less toxic, enzyme-based treatment could be provided for a higher cost, but specific figures are not yet available for this option. Assuming use of the lower-

cost disinfection option, total annual maintenance costs come to $7,000 to $7,400, not including up-front capital costs for maintenance equipment.

Table 7: Marblehead Town Fields: Synthetic Turf Maintenance Costs (65,340 sf)	
Maintenance equipment	
Gator utility vehicle	$10,000 - $14,000
Brusher	$7,500
Annual costs	
Grooming	$1,000 - $1,400
Disinfection (chemical)	$6,000
Total annual costs (not including equipment)	**$7,000 - $7,400**
Source: Osborne, Charles, Chairman of the Recreation and Park Commission, Marblehead, personal communication, May 26, 2016.	

The costs shown in the table above are for an approach that uses both town staff and an outside vendor. To gain more information on costing options, the town of Marblehead obtained a cost quote for synthetic turf maintenance performed entirely by an outside contractor.

For two maintenance visits per year (including grooming, cleaning, de-compacting, field inspection, G-max testing, and infill depth measurements) the total came to $5,300 per year. A higher cost option provides six visits per year, with disinfectant applied at each visit, as well as minor repairs. This option is offered for $6,800 per year (Osborne 2016).

Variations in the approach to maintenance could lead to changes in cost. For example, use of a safer, enzymatic product in place of chemical disinfection would be available at a higher cost. It is also important to note that the maintenance programs offered by many providers may not meet the specifications provided by the manufacturer in the product manual (Osborne 2016).

Fifteen acres of playing fields in Marblehead are managed organically. Annual maintenance costs are $2,400-$3,000 per 2-acre playing field, not including mowing costs. Mowing costs for a 2-acre field have been estimated to be $10,000 annually for a total of 26 cutting weeks (using 2010 dollars) (Osborne 2016). Thus, total maintenance costs per 2-acre field are $12,400 to $13,000 annually.

Maintenance: Conventional vs. Organic. Organic turf management can be cost-competitive with conventional management of natural grass. In Marblehead, a conventional athletic field maintained by a conventional land care company for the same two-acre area noted above is estimated at $3,400, not including mowing. Thus, the maintenance cost for established organic playing fields is lower than ongoing maintenance costs for conventional grass fields of the same size.

One study found that once established, an organic turf management program for school athletic fields can cost 25% less than a conventional turf management program, as shown in Table 8, below (Osborne & Wood 2010).

Table 8 below further illustrates the differences in cost in a 5-year comparison.

Table 8: Cost comparison of conventional vs. organic turf management*						
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Total**
Conventional	$8,222	$8,544	$9,055	$9,755	$10,279	$45,855
Organic	$9,782	$9,553	$8,497	$7,268	$7,642	$42,742
Source: Osborne, Charles and Wood, Doug, "A Cost Comparison of Conventional (Chemical) Turf Management and Natural (Organic) Turf Management for School Athletic Fields", Grassroots Environmental Organization, March 2010. *Costs include products, labor, irrigation, and indirect costs.						

Disposal/replacement

Artificial turf also requires removal and replacement at the end of its useful life. These costs can include removal, resurfacing, transportation, and landfill surcharges.

The Turfgrass Resource Center estimates the cost for removal and disposal of an artificial surface at $1.75 to $2.25 per square foot, not including transportation costs and any landfill surcharges that disposal might incur (TRC n.d. b). This would yield approximately $115,000 - $148,000 for a 65,625 square foot field and $149,000 - $191,000 for an 85,000 square foot field.

The SportsTurf Managers Association estimates costs of $6.50 to $7.80 per square foot for disposal and resurfacing (STMA n.d.). Those estimates yield approximately $427,000 - $512,000 for a 65,625 square foot field and $553,000 - $663,000 for an 85,000 square foot field.

The STMA also estimates the transportation and landfill charges for disposal of a crumb rubber field at $130,000. (STMA n.d.) Landfill tipping fees alone have been estimated at $45,000 to $65,000 for synthetic turf fields (Fresenburg 2015).

The disposal costs are summarized below in Table 9.

Table 9: Disposal Cost Summary*		
	62,625 sf field	**85,000 sf field**
Removal & disposal (TRC)	$115,000 - $148,000	$149,000 - $191,000
Disposal & resurfacing (STMA)	$427,000 - $512,000	$553,000 - $663,000
Transportation & landfill (STMA)	$130,000	
Total (STMA) [disposal & resurfacing + transportation & landfill]	$557,000 - $642,000	$683,000 - $793,000
Landfill (Fresenburg) [no field size given]	$45,000 - $65,000	
* Rounded to three significant digits. Sources: Turfgrass Resource Center. (no date.) "Natural Grass and Artificial Turf: Separating Myths and Facts." Available at http://www.nsgao.com/images/Natural-Grass-and-Artificial-Turf_booklet.pdf. STMA. (no date.) "A guide to Synthetic and Natural Turfgrass for Sports Fields, 3rd edition. Available at http://www.stma.org/sites/stma/files/STMA_Bulletins/STMA%20Syn%20and%20Nat%20Guide%203rd%20edition%20FINAL.pdf. Brad Fresenburg, "More Answers to Questions about Synthetic Fields – Safety and Cost Comparison", Turfgrass Specialist & Extension Associate, University of Missouri. PowerPoint slides obtained via email December 2015.		

Annualized life cycle costs

Capital investment, annual maintenance costs, and disposal costs are all noted above. These can be brought together in a single figure by calculating annualized life cycle costs. Below we summarize the findings of two studies that developed annualized costs, and provide an additional sample calculation based on figures from STMA.

Missouri University Extension study. In 2008, a Missouri University Extension study calculated annualized costs for a 16-year scenario – based on their own raw data, not necessarily the numbers specifically cited above. The calculation included the capital cost of installation; annual maintenance; sod replacement costing $25,000 every four years for the natural fields; and surface replacement of the synthetic fields after eight years. Based on this calculation, a natural grass soil-based field is the most cost effective, followed by a natural grass sand-cap field, as shown in Table 10 below (Fresenburg 2015).

Table 10: Comparison of annualized costs

Field type	16-year annualized costs
Natural soil-based field	$33,522
Sand-cap grass field	$49,318
Basic synthetic field	$65,849
Premium synthetic field	$109,013

Source: Brad Fresenburg, "More Answers to Questions about Synthetic Fields – Safety and Cost Comparison", Turfgrass Specialist & Extension Associate, University of Missouri. PowerPoint slides obtained via email December 2015.

Western Australia Department of Sport and Recreation. Another life cycle cost calculation has been developed by the Western Australia Department of Sport and Recreation, which published a decision maker's guide to natural grass versus synthetic turf likely in 2012 (the exact date is not known and we were not able to confirm with the authors). The report takes into account the life cycle implications of planning, acquiring, operating, maintaining and disposing of a field. The report considers several types of sport fields; of these, the data for soccer fields are shown below, as these are likely to be most applicable to a US context. The report distinguishes between community level playing fields and elite level playing fields, with a higher level of maintenance assumed for an elite level field. Table 11, below, summarizes the data for soccer fields. We assumed the report provided cost figures in Australian dollars, and converted them to US dollars. As shown in the table, the 25-year and 50-year life cycle costs for synthetic turf are about 2.5 times as large as those for natural grass.

Table 11: Australian Life Cycle Costs – Soccer Field				
	Community Level		**Elite Level**	
	Natural Grass	Synthetic Turf	Natural Grass	Synthetic Turf
Construction Costs	153,000	508,000		
Annual Operating Costs	20,000	18,000	25,000	18,000
25 Year Life Cycle Cost	724,000	1,813,000		
50 Year Life Cycle Cost	1,295,000	3,118,000		

* Note: These costs are not identified as community or elite in report.
Source: Government of Western Australia, Department of Sport and Recreation, "Natural Grass vs Synthetic Turf Surfaces Study Final Report" (date tbd), accessed at http://www.dsr.wa.gov.au/support-and-advice/facility-management/developing-facilities/natural-grass-vs-synthetic-turf-study-report. Costs were originally provided in Australian dollars and were converted to US dollars using the May 2016 conversion rate of 0.72 US dollars to 1.0 Australian dollar.

Life cycle costs based on STMA information. To add additional perspective, for purposes of this report we have calculated a life-cycle cost over 16 years based on the costs estimated by STMA for installation, maintenance, labor and replacement/disposal for a 65,625 square foot field. This is a simplified calculation and is not intended to cover all scenarios. As shown in Table 12 below, we have estimated an hourly labor rate of $20 and an interest rate of 3%.

We also had to make certain assumptions regarding the state of the field in the final year of the scenario (in this case, year 16). We chose to work with a scenario in which the field is in excellent condition in year 16. Thus, we have assumed that that the synthetic field is fully replaced in year 16, making it possible to continue playing on the field in the future.

For a natural grass field, certain high-impact sports such as football make it necessary to periodically replace portions of sod. We have assumed that portions of the field are replaced periodically, so that there is no effect of wear and tear at the end of the calculation period, and the field is equally playable in year 16 as it was in year 1.

The cost of sod replacement can be estimated either as an annual average, or as a periodic cost. We have used an estimate of sod replacement at years 6, 11, and 16, for a cost each time of $25,000 to $45,000. These estimates are based loosely on the experience of the Marblehead grounds manager with one sample field in the first decade of the field's use. (An alternative approach is to estimate an annual average cost for sod replacement. One estimate of annual expenditures on sod replacement provides a range from $800 to $12,000 [TRC n.d.]; an annual average would thus be around $6,700 per year. This approach yields similar final values.)

Based on these assumptions, for a 16-year period, the net present value for a natural field ranges from about $219,000 to $799,000. The net present value for a synthetic field runs from about to $1.2 to $1.7 million.

Each of the estimates used in this calculation could be modified for greater precision. The replacement cycle for some synthetic fields may be considerably longer than 8 years; these fields may also have higher maintenance costs in the intermediate years, include periodic additions of infill. Installation costs for synthetic fields also vary depending on the type of infill used. For natural grass, similarly, there are many sources of variability; for example, average annual sod

replacement costs could be lower or higher for some fields, depending on other maintenance parameters as well as the type of sports played on the fields.

Table 12: Sample Life Cycle Cost Estimate (65,625 square foot field)				
	Natural		*Synthetic (replacements in years 8 & 16)*	
	Low	High	Low	High
Installation*	$39,000	$328,000	$295,000	$673,000
Annual Maintenance*	$4,000	$14,000	$4,000	$4,000
Annual Labor (hrs)*	250	750	300	300
Annual labor cost	$5,000	$15,000	$6,000	$6,000
Resodding (yrs 6, 11, 16)	$25,000	$45,000	$0	$0
Disposal & resurfacing & transport & landfill*	$0	$0	$557,000	$642,000
Net Present Value	**$197,000**	**$753,000**	**$1,189,000**	**$1,676,000**

*Source: SportsTurf Managers Association. [no date.] A Guide to Synthetic and Natural Turfgrass for Sports Fields. 3rd edition. Lawrence, KS: STMA. Assumptions: Hourly rate $20; interest rate 3%, disposal/resurfacing occurs in years 8 & 16; natural grass resodding in years 6, 11 and 16; conversion factor used to calculate annualized cost from NPV 0.0796. In the scenarios used here, at year 16 the field is in equally good condition as in year 1.

Other factors

When considering life cycle costs it is important to recognize the variability in field use, quality of playing surface, regional climate, and other factors that may influence the useful life of the product. Manufacturers provide estimates of product life, and some fields may be used over their recommended life and others may be replaced earlier

When using the information provided here, please note it is also important to consider the size of the specific field in question. Towns may also wish to consider cost as related to the total number of events on the field, which are not calculated here. Field use time is discussed in a separate section of this report.

Summary

In this section, we have presented costs for installation, maintenance, and disposal/replacement for natural grass and artificial turf fields. The information is drawn from industry association sources, university projects, and the experience of individual Massachusetts municipalities. Even with varying assumptions and parameters, the information reveals a consistent trend.

In summary, when considering the costs of artificial vs. natural turf, institutions should consider the full life-cycle cost. A wide variety of site-specific considerations may affect field costs. In nearly all scenarios, the full life-cycle cost of natural turf is lower than the life-cycle cost of a synthetic turf field for an equivalent area.

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The Toxics Use Reduction Institute is a multi-disciplinary research, education, and policy center established by the Massachusetts Toxics Use Reduction Act of 1989. The Institute sponsors and conducts research, organizes education and training programs and provides technical support to help Massachusetts companies and communities to reduce the use of toxic chemicals.

In response to information requests from municipalities, TURI is currently developing a detailed alternatives assessment for sports turf. Preliminary sections of the assessment are being published in the order in which they are developed, and are available on TURI's website at www.turi.org.

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Athletic Playing Fields

Choosing Safer Options for Health and the Environment

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TURI
TOXICS USE REDUCTION INSTITUTE
UMASS LOWELL

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Athletic Playing Fields: Choosing Safer Options for Health and the Environment

Introduction

Municipalities, universities, schools and other institutions frequently need to make decisions about maintenance and installation of athletic playing fields. This may include choosing between natural grass and artificial turf (also referred to as synthetic turf). Factors that may be considered include cost of installation and maintenance, number of days the field can be used, likelihood of player injuries, temperature of the playing environment, and athletes' exposure to chemicals.

A number of communities have requested technical assistance from TURI in evaluating the questions they face as they make these decisions. In response to these requests, TURI has conducted research on individual materials used in artificial turf. TURI has also worked with municipalities and other institutions to facilitate the adoption of athletic field management practices that are cost-effective and preferable for human health and the environment. This area of work has included projects to help communities eliminate or reduce the use of pesticides and facilitate the adoption of organic grass management practices.

This document provides information based on TURI's research on selected materials used in artificial turf. It also includes information on organic management of natural grass. TURI has identified organically managed natural grass as a safer alternative for sports surfaces. Additional educational documents and video resources are available on TURI's website.[1]

Principles of Toxics Use Reduction

TURI's work is based on the principles of toxics use reduction (TUR). The TUR approach focuses on identifying opportunities to reduce or eliminate the use of toxic chemicals as a means to protect human health and the environment. Projects to reduce the use of toxic chemicals often have additional benefits, such as lower life-cycle costs.

Children's Environmental Health

People of all ages benefit from a safe and healthy environment for work and play. However, special concerns exist for children. Children are uniquely vulnerable to the effects of toxic chemicals because their organ systems are developing rapidly and their detoxification mechanisms are immature. Children also breathe more air per unit of body weight than adults, and are likely to have more hand-to-mouth exposure to environmental contaminants than adults.[2] For these reasons, it is particularly important to make careful choices about children's exposures.

Artificial Turf Components

Artificial turf generally has several components, including a base layer made from gravel or stone; an artificial grass carpet, including a backing material and artificial grass fibers; and one or more infill materials, used to hold the grass fibers upright and provide cushioning, among other functions. Infill is the portion of the artificial turf that mimics the role of soil in a natural grass system. Many artificial turf fields also include a shock pad below the carpet for additional cushioning.[3] Depending on the infill type, this shock pad may be an optional component of the turf system, or may be required in order to provide a sufficiently resilient playing surface.

This document provides information on several infill materials. It is important to note that the materials available on the market may change frequently and the information presented here is not comprehensive. It is also important to understand that infill is just one component of an artificial turf system. This document focuses primarily on infill, but in evaluating the health and environmental impact of artificial turf, it is also important to consider the impacts of all the components, including the artificial grass blades, shock pad, and lower structural layers.

Regulatory/Testing Standards

There is no comprehensive regulatory or testing regimen specifically for artificial turf.

The standard cited most frequently by vendors is European Standard EN 71-3 – "Safety of Toys Part 3: Migration of certain elements" (the European Toy Safety Standard). For communities applying this standard, it is important to understand that it focuses only on metals. It does not cover other compounds that may be found in artificial turf materials, such as volatile organic compounds (VOCs), polyaromatic hydrocarbons (PAHs), phthalates, and others. The standard includes three different safety levels, so it is important to understand which level has been applied. Detailed information on this regulation is available in another TURI publication, *Chemicals in Artificial Turf Infill: Overview*.[4]

Other standards sometimes applied by researchers to artificial turf include regulatory standards for contamination of soil (e.g., comparing lead levels to those considered by the US EPA to pose a "soil-lead hazard" in play areas);[5] and checking metals in artificial turf runoff against federal and state regulatory levels for drinking water, surface waters and groundwater.[6] Studies in Europe have checked chemical levels in infill against a variety of regulatory standards for soil, sediment, and building materials, among other standards.[7] Germany has developed a regulation specifically for artificial turf, including requirements related to leaching of certain metals and organic compounds.[8]

Another relevant standard is California’s Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65). This law requires disclosure of the presence of chemicals that are identified by the state of California as causing cancer or reproductive harm.

Artificial Turf: Chemicals in Infill

TURI has received many queries from communities and institutions that are working to understand the health and safety profiles of a variety of infill types. Therefore, TURI has reviewed existing literature on these infill types, with a focus on chemicals found in the materials. Additional detail on selected individual infills can be found on TURI's website.[9]

It is important to note that chemicals in infill are just one piece of the picture. The artificial grass blades pose concerns as well. Toxic chemicals such as lead are found in the artificial grass blades in some cases.[10] It is also important to understand and research the materials used in any pad or underlayment used in the layers below the infill.

Overview

Crumb rubber made from recycled tires, also referred to as **tire crumb** or as styrene butadiene rubber (SBR), is present in a large number of artificial turf fields.

A number of materials are currently marketed as alternatives to recycled tires. Some are based on synthetic materials, while others are mineral- or plant-based, or contain a mixture of natural and synthetic materials. Alternative synthetic infills include **ethylene propylene diene terpolymer (EPDM)**, **thermoplastic elastomer (TPE)**, and **waste athletic shoe materials**, among others. **Mineral-based** and **plant-derived** materials used in infill can include sand, zeolite, cork, coconut hulls, olive cores, and walnut shells, among other materials. Infill can also be made with acrylic-coated sand.

Some vendors may also offer an option of tire crumb coated with polyurethane. Limited information is available on the chemicals in the coating, the ability of the coating to reduce exposure to chemicals in the tire crumb, or the durability of the coating.[11]

Relatively little information is available on the chemicals present in, or emitted from, alternative infills. Some of them may pose less of a concern than tire crumb, but some may introduce serious hazards. Some available information on these materials is provided here, but there is a need for more research on all of these materials. Some of these materials have also been evaluated in a 2017 review by the Norwegian Environmental Agency[12] and in a 2018 review by the National Institute for Public Health and the Environment (RIVM) in the Netherlands.[13]

This overview is not comprehensive. New infills are introduced to the market frequently. It is important to understand that any synthetic material used as infill will pose some concerns related to introduction of rubber or plastic particles into the environment, as well as whatever specific chemicals may be found in the material. Mineral- and plant-based infills can pose hazards as well. In addition to any issues associated with infill, all artificial turf introduces synthetic materials into the environment through the other components, including breakdown over time of the artificial grass carpet.

Understanding rubber and plastic products: terminology

For those interested in understanding more about rubber and plastic products, the following terminology may be useful.

Thermosets vs. thermoplastics. Both natural and synthetic rubbers are **thermosets**. A key characteristic of a thermoset is that although heat is used in the initial manufacture of the material, once the material has been formed, it cannot be melted. For this reason, tires and other products made from thermosets cannot be melted and re-formed into new products. Among the materials used in artificial turf infills, SBR, EPDM and shoe sole materials are all thermosets.

Thermoplastics, in contrast, are materials that can be melted and re-formed into new shapes. Thermoplastic elastomers (TPEs) are one broad category within the larger category of thermoplastics.

Curing/crosslinking/vulcanization. Thermosets gain their stability through a process of **curing**, also referred to as crosslinking or vulcanization. Curing is a process of creating links among polymer strands in order to create a stable, three-dimensional structure. In the case of a thermoset, these links are composed of irreversible chemical bonds.

A variety of chemicals can be used in the curing process. These include chemicals that become part of the crosslinking bond, as well as chemicals that catalyze or accelerate the crosslinking process. The term "vulcanization" is often used specifically to refer to crosslinking with sulfur.

In contrast to the large molecules of a polymer, the molecules added in the curing process are often relatively small. Some of these molecules may remain present as free molecules in the final material, and these may be released during product use.

Plasticizers. Plasticizers are added to stiff or rigid materials to make them more pliable. One important category of plasticizers is the phthalate esters, also commonly referred to simply as phthalates. Mineral oil can also be used as a plasticizer. The specific plasticizers used in a given product are frequently not disclosed.

Other additives. A variety of other additives may be used in rubber and plastic products. **Fillers** such as carbon black or silica can be used to attain specific material properties or simply to extend the volume of the material. **Stabilizers** can be added to decrease the effect of light, heat or other environmental conditions on the material. Other additives that may be used include **pigments** and **antimicrobial agents**.

Tire crumb

A large number of chemicals are found in tire crumb. Many of these have adverse effects on human health or the environment. In a literature review, the US Environmental Protection Agency (EPA) identified just over 350 chemicals or chemical categories that were discussed in existing literature on tire crumb.[14] The presence and amount of a given chemical can vary depending on the sample of tire crumb.

Table 1 shows the categories of chemicals considered by EPA, with examples of individual chemicals in each category.[15] As shown in the table, these include metals, such as lead and zinc; volatile organic compounds (VOCs); semi-volatile organic compounds (SVOCs); and a variety of uncategorized chemicals including vulcanization compounds (chemicals used in rubber curing). The broad category of SVOCs includes PAHs, phthalate esters, and chemicals that may be applied to the crumb rubber as biocides during the life of the artificial turf.

Some of the chemicals found in tire crumb are endocrine disrupters (e.g., phthalate esters); some are known or suspected carcinogens (e.g., arsenic, cadmium, benzene, styrene); and some are associated with other human health effects.[16] A recent study evaluated the potential carcinogenicity of 306 chemicals found in tire crumb and found that 197 of them met certain carcinogenicity criteria, while 58 were actually listed as carcinogens by a government agency.[17]

Table 1: Selected categories of chemicals found in tire crumb

Category[a]	Subcategory	Examples
Metals		Aluminum, arsenic, barium, cadmium, chromium, copper, lead, nickel, zinc
VOCs		Benzene, benzothiazole, hexane, naphthalene, styrene, toluene, xylenes
SVOCs	PAHs	Anthracene, benz(a)anthracene, fluoranthene, naphthalene, phenanthrene, pyrene
	Phthalate esters	Benzylbutyl phthalate, di(2-ethylhexyl)phthalate [a.k.a. bis(2-ethylhexyl)phthalate]
	Biocide product ingredients	May include quaternary ammonium compounds such as alkylbenzyldimethyl ammonium chloride, alcohol ethoxylate 6, or others[b]
Other[c]		4-tert-(octyl)-phenol [a.k.a. 4-t-octylphenol], butylated hydroxytoluene

Sources:
Thomas K, Irvin-Barnwell E, Giuseppi-Elie A, Ragin-Wilson A. August 2016. *Research Protocol: Collections Related to Synthetic Turf Fields with Crumb Rubber Infill.* US EPA, CDC and ATSDR. Accessed at https://www.epa.gov/sites/production/files/2016-08/documents/tcrs_research_protocol_final_08-05-2016.pdf, January 2, 2017.
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[a] Note: Categorization shown here follows categories used in EPA's August 2016 publication.
[b] Thomas et al. note these have been identified by the California Office of Environmental Health Hazard Assessment (OEHHA) as "potential turf biocides."
[c] As organized by Thomas et al., this category includes "potential rubber curatives, antioxidants/antiozonants, and other chemicals reported in literature."

Exposure to low doses of multiple chemicals can have health effects that may not be predicted based on the expected effects of each exposure individually. For this reason, some studies have considered the mix of chemicals in tire crumb, rather than looking at each individually. A study of a tire shredding facility in Taiwan tested airborne particulates from the facility for mutagenicity, and found that they showed "a substantial presence" of mutagens.[18] Another study considered the mutagenicity of dust and fumes at two tire-shredding facilities; they found "high mutagenic activity" of dust and fumes at one facility and "almost no mutagenic activity" at the other, a difference they attributed both to choices of chemicals and to the way in which each facility operated.[19]

EPDM

EPDM rubber is a specialty elastomer that can be mixed with high levels of additives and oils while retaining its desirable physical properties, including strength and resistance to tearing. Additives can include oil, carbon black, and other materials. EPDM may be manufactured with anywhere from 15 to 100 parts of oil per 100 parts of polymer.[20] Like tire crumb, EPDM is a vulcanized (cured) rubber product, so it can be expected to contain vulcanization compounds. Not all EPDM infills are necessarily the same, so it is important to find out what chemicals are present in any given EPDM product.

There has been limited examination of EPDM granules to evaluate their suitability from a public

health and environmental perspective. In one study published in 2004, the Norwegian Building Institute (NBI) examined levels of selected chemicals in one sample of EPDM infill, comparing these levels with those found in three samples of recycled tires. The study found that the EPDM rubber contained more chromium than the tire material, similar amounts of zinc, and lower concentrations of PAHs, phthalate esters, and phenols. Polychlorinated biphenyls (PCBs), which were found in one sample of recycled rubber, were not found in the EPDM. The authors state that "with the exception of chromium and zinc, the EPDM rubber contains lower concentrations of hazardous substances than the recycled rubber types overall."[21] A 2008 study by the Danish Ministry of the Environment also included tests of one sample of EPDM.[22] A study supported in part by the tire industry in France found that EPDM emitted larger amounts of VOCs than tire crumb.[23]

In reviewing pros and cons of EPDM infill, the Norwegian Environmental Agency notes possible concerns about VOC emissions at indoor fields, introduction of microplastics into the environment, and aquatic toxicity from leachate, among other factors.[24]

RIVM reviewed the limited existing literature on EPDM infill as well as conducting limited testing of its own. RIVM concludes that EPDM infill is likely to contain PAHs but at lower levels than tire crumb; carbon black may be a concern in black EPDM, but not in EPDM of other colors; and phthalate esters such as diethylhexyl phthalate (DEHP), an endocrine disrupter, may be present in the material. Nonyl- and octylphenols, also endocrine disrupters, are detected at low levels in both EPDM and tire crumb. RIVM also notes that leaching of zinc from EPDM could potentially pose a concern similar to the level of concern posed by tire crumb.[25]

In summary, EPDM may pose some of the same health and environmental concerns posed by tire crumb, although it may contain lower levels of some important categories of chemicals of concern and a smaller number of chemicals of concern, compared with tire crumb. Additional detail on EPDM infill is available on TURI's website.[26]

TPE

Thermoplastic elastomer[27] (TPE) is a general term that can encompass a variety of materials. TPEs are composed of two materials: one that is hard at room temperature and one that is soft and rubbery at room temperature. The two materials can be either chemically bonded or blended together.

TPEs generally do not require curing or vulcanization during manufacturing. However, some products marketed as TPE do contain a vulcanized material as one part of the mix, further complicating the distinctions among material types.

As with EPDM infill, TPE infill has not been studied extensively. Based on the limited information available on TPE used in artificial turf infill materials, it appears to contain lower levels of many toxic chemicals than tire crumb. In particular, measurements indicate that TPE infill emits fewer VOCs. Furthermore, since TPE does not require vulcanization (curing), it is generally expected to be free of the vulcanizing agents that are used in crumb rubber made from tires.[28] However, TPE infill can contain and emit some chemicals of concern, and since individual TPE products may vary widely, it is important to obtain information on the chemicals found in any individual product that is under consideration.

Although the term TPE encompasses a broad category of materials, TURI examined details about one TPE infill to better understand the chemical composition. Using information obtained from Safety Data Sheets and the US National Library of Medicine's database (ChemID*plus)*, the TPE sample was found to be composed of styrene block copolymer, polyethylene, paraffin oil, calcium carbonate (chalk), carbon black, and unspecified stabilizers/antioxidants. Carbon black is identified

by the International Agency for Research on Cancer as a possible human carcinogen (Group 2B), and many forms contain a variety of adsorbed compounds, including PAHs.[29]

A 2006 study by the Norwegian Pollution Control Authority compared three indoor fields: two containing crumb rubber (SBR) infill made from tires, and one containing TPE infill.[30] In measurements of airborne dust, the quantity of fine particulate matter ($PM_{2.5}$) was elevated for the two SBR fields, while quantities were in the expected ranges for an indoor setting for the TPE field. The researchers also noted that the dust generated by the TPE field was free of the vulcanization compounds, preservative compounds, and carbon black found in the SBR fields. Dust from all locations contained PAHs, but the levels in the dust generated by the TPE field were lower than those in the SBR dust. Total VOCs measured at the TPE field were also lower than those measured at the tire crumb fields. Phthalate esters were present at comparable levels at all locations; phthalate esters measured in airborne dust during one time period were slightly lower at the TPE field, but were higher at the TPE field during another time period.

RIVM's literature review suggests that little information is available on TPE infills, but that they are likely to contain lower levels of metals and VOCs than tire crumb or EPDM, lower or comparable levels of PAHs, and comparable levels of phthalate esters.[31]

In summary, based on the limited information that is available, TPE infill is likely to contain fewer chemicals of concern than tire crumb, but is still likely to contain some chemicals of concern. Communities considering purchasing a TPE infill product may wish to request additional information from the vendor on the specific type of TPE used. Additional detail on TPE infill is available on TURI's website.[32]

Waste shoe material

Infill made from post industrial waste shoe material can be made from a single brand of shoe product, or from several mixed together. For example, the Sole Revolution brand of infill may draw materials from a variety of shoe manufacturers, while Nike Grind is made from Nike® shoe material.[33]

Shoe manufacturing uses a wide variety of materials, and manufacturers' choices about these materials vary over time. Factors relevant to the environmental, health and safety characteristics of athletic shoe materials include the polymers used in shoe soles, the additives that impart key performance characteristics to those polymers, and the mandatory and voluntary testing protocols used to limit toxics in shoe materials.

Some shoe materials are governed by Restricted Substances Lists (RSLs) developed by shoe manufacturers to minimize or eliminate the use of certain chemicals that pose particularly high concerns. For example, Nike has an RSL that "restricts approximately 350 substances that have been regulated or voluntarily phased out of [their] manufacturing processes,"[34] and Nike Grind materials are governed by the RSL.[35]

According to Nike's RSL, certain VOCs (such as benzene or toluene) are subject to tight control in the manufacturing process. Thus, these substances are not necessarily absent from Nike products but they are used in the minimum quantity possible to achieve the desired effect. Nike also limits the levels of other categories of chemicals of concern, such as specific PAHs and specific phthalate esters.[36]

Waste shoe material can contain some of the same chemicals of concern as other rubber infills, although it offers the advantage that levels of some of the chemicals of highest concern may be regulated by an RSL. Neither of the recent assessments by European government agencies considered waste shoe material in detail as an

alternative to tire crumb. TURI has not identified detailed independent studies of waste shoe material as used in infill.

Acrylic-coated sand

TURI was able to gather information on one acrylic-coated sand product that is currently marketed for use in artificial turf.[37] According to the manufacturer, this product is composed of well-rounded sand, a proprietary (undisclosed) acrylic, a Microban® antimicrobial, and a pigment.[38]

The specific acrylic used in the product is a proprietary component of the manufacturer's production process, so no other information was available on its health and environmental properties. According to the manufacturer, it does not contain any additives beyond the pigment and antimicrobial.[39] Laboratory test results provided by the manufacturer show that all PAHs for which tests were conducted were below the detection limit.[40] The manufacturer also states that the product was below the detection limit for all VOCs for which tests were conducted.[41]

The antimicrobial helps to protect the acrylic coating from deterioration. The company currently uses ZPTech®, a zinc-based antimicrobial. According to the Microban website, "ZPTech is a broad-spectrum antimicrobial."[42] According to Microban, the product "encapsulates zinc pyrithione in customized carriers." Zinc is released when the material is exposed to water.[43] The product is also available without the antimicrobial.

According to the manufacturer, the antimicrobial product originally used in the product was triclosan, but the transition to the zinc-based antimicrobial has been complete since the end of 2016.[44] Triclosan poses concerns based on bioaccumulation and adverse health and environmental effects.[45]

Test data are available both for presence of metals in the material and for leaching of metals from the material. The metal that appears in the largest quantity is zinc (18 and 57 mg/kg in two samples respectively). Tests show that the material leaches 0.82 mg/L of iron and 0.13 mg/L of zinc.[46]

Many of the categories of organic chemicals of concern that are present in the other synthetic infills may be lower, or absent, in acrylic-coated sand. On the other hand, there may be a need for more research on the environmental implications of the broad use of sand coated with an antimicrobial-infused polymer.

Mineral- or plant-based materials

A growing list of mineral- or plant-based materials is marketed for use in infill. At least one of these options, zeolite, poses serious health concerns. The other materials have generally not been studied in depth. As with the other materials discussed in this report, it is essential to gather detailed information on these materials to understand their potential health or environmental impacts. This section mentions a few areas of concern, but is not comprehensive.

Zeolite. Zeolite poses a respiratory hazard. Animal studies suggest that exposure to some types of zeolites may be associated with increased risk of developing mesothelioma.[47] Erionite, one type of zeolite, poses particular concerns; its health effects can be similar to those of asbestos.[48]

Cork. Respiratory disease has been documented in cork workers exposed to cork dust. For example, a 1973 study concluded that workers in the cork industry may suffer from various complaints related to the inhalation of cork dust. It states that "workers in factories where cork is processed and transformed into commercial products may acquire incapacitating disease of the respiratory tract."[49] Respiratory disease associated with cork dust exposure is known as suberosis. Fungi that frequently colonize cork appear to play some role in the disease, although the disease is not fully understood.[50]

Coconut fiber. Some individuals are allergic to coconut, although coconut allergies are relatively rare. The American College of Allergy, Asthma & Immunology notes that "coconut is not a botanical nut; it is classified as a fruit, even though the Food and Drug Administration recognizes coconut as a tree nut. While allergic reactions to coconut have been documented, most people who are allergic to tree nuts can safely eat coconut."[51]

Walnut shells. Nut shells may pose concerns related to allergies if nut allergens are present on the shells. Walnut shells are used as an alternative to silica in sand blasting, and there is one report of an individual developing an allergic reaction in that context.[52] According to the manufacturer, USGreentech, the shells used in Safeshell[53] (a proprietary infill made from walnut shells) are processed to remove allergens to "below 2.5 parts per million."[54]

Fibers. A variety of respirable plant-based fibers can cause disease and disability. For example, cotton dust is a well-known source of respiratory disease.[55] TURI has not identified any studies that consider possible hazards related to plant-based fibers in infill.

Comparing infills

As noted above, infills are just one part of an artificial turf system and all portions of the system should be evaluated as part of the decision making process. Table 2 provides comparative information on selected chemicals or chemical categories in infill materials.

Most infill vendors are able to provide test results for a number of metals. The information on metals in this table is drawn primarily from one set of tests on individual infill products provided by a vendor of multiple infill types. The table shows specific information on lead because it is a particular concern for children's health, and zinc because it has been flagged as a possible environmental concern associated with artificial turf. However, other metals may be equally or more important. Communities working to make a decision should request the most up-to-date results on metals present in the specific product they are considering.

Information on other chemicals may not be as readily available from vendors. Communities may wish to request information on organic chemicals, such as VOCs or PAHs, found in any specific product. Note that the term "organic" in this context refers to any chemical that is based on carbon. This is not the same as the use of "organic" to describe pesticide-free management of natural grass systems.

As shown in the table, vulcanization compounds are likely to be found in tire crumb, EPDM, and shoe materials. VOCs have been measured in many of the materials, but are higher in some than in others. Similarly, PAHs may be present in varying quantities depending on the material. There may be some increased predictability when purchasing waste shoe materials if they are subject to an RSL. Mineral- and plant-based materials are unlikely to pose concerns related to the four broad categories of synthetic chemicals listed in the table, but some pose other significant concerns. It is important to note that even in cases where the chemicals listed below may be absent, infills may pose other hazards.

In the course of TURI's research, a number of data gaps were identified. For example, not all vendors were able to provide information on PAHs in infill products. To help address this data gap and better understand the presence of PAHs in these materials, TURI contracted with the Icahn School of Medicine at Mount Sinai to conduct limited testing on samples of commercial infill products. As shown in Table 2, the tire crumb sample contained the largest total PAH concentration, with over 500 mg/kg. Waste athletic shoe material and EPDM had the next largest total PAH concentrations, although they were both an order of magnitude lower than tire crumb (55 and 20 mg/kg respectively).[56]

Table 2: Comparing infills: Selected categories of chemicals of concern

Category	Tire crumb	EPDM	Shoe materials[a]	TPE	Acrylic-coated sand	Mineral- or plant-based
Lead[b]	Present	Present	Present	Present	Below detection limit[c]	Absent in some cases
Zinc[b]	Present	Present	Present	Present	Present[c]	Present in some cases
Other metals[b]	Present	Present	Present	Present	One additional metal present[c]	Present
Vulcanization compounds[d]	Present	Present	Present	Generally absent	Expected to be absent	Zeolite, when present, poses serious respiratory hazard. Plant-based materials can pose concerns related to dust, fungi, or allergens. Vulcanization compounds and phthalates are expected to be absent; VOCs and PAHs are expected to be low or absent.[h]
Phthalates	Present[e]	Present (lower)[f]	May be present, but subject to RSL	Present[g]	Expected to be absent	
VOCs	Present[e]	Present (lower in some cases, higher in others)[f]	Expected to be present, but subject to RSL	Present (lower)[g]	Expected to be absent	
PAHs	Present[e]	Present (lower)[f]	May be present, but subject to RSL	Present (lower)[g]	Below detection limit[c]	
PAHs (TURI sample)[i]	Present (highest) (548 mg/kg)	Present (20 mg/kg)	Present (55 mg/kg)	Present (below 10 mg/kg)		

[a] Some information in this column is drawn from Nike's RSL. *VOCs:* Nike's RSL restricts benzene to 5 ppm and a number of other VOCs to a total of 1,000 ppm. *PAHs:* Nike's RSL restricts certain PAHs to 1 ppm each and sets a 10 ppm total for all PAHs on the list. *Phthalate esters:* Certain phthalate esters are listed on the Restricted Substances Lists (RSLs) of major shoe manufacturers. Specifically, Nike restricts all ortho-phthalates to a total of 1,000 ppm.

[b] Except where otherwise noted, information is drawn from Labosport. 2014. *Technical Report: Toxicological Analysis of Performance Infill for Synthetic Turf Fields according to EN 71-3 Standard – Safety of Toys Part 3: Migration of Certain Elements.* Report #R14565CAN-A1, provided to Jason Smollett, FieldTurf.®

[c] AIRL, Inc. 2018. Lab report #304074, provided to Ross Vocke, US Greentech. Detection limit 10 µg/Kg for PAHs, 0.25mg/Kg for metals.

[d] By definition, the vulcanized rubber products (tire crumb, EPDM and shoe materials) may contain residual vulcanization compounds. TPE is not vulcanized; however, in some cases, products marketed as TPE are a blend that also contains vulcanized rubber.

[e] US EPA. 2016. *Federal Research Action Plan on Recycled Tire Crumb Used on Playing Fields and Playgrounds: Status Report.* EPA/600/R-16/364. Viewed on October 23, 2018, at https://www.epa.gov/sites/production/files/2016-12/documents/federal_research_action_plan_on_recycled_tire_crumb_used_on_playing_fields_and_playgrounds_status_report.pdf.

[f] Norwegian Building Research Institute (NBI - BYGGFORSK). 2004. "Potential Health and Environmental Effects Linked to Artificial Turf Systems: Final Report." Report prepared for the Norwegian Football Association. Project no. 0-10820. September 10, 2004. Authors: Thale S.W. Plesser, Ole J. Lund. Moretto R. 2007. *Environmental and health assessment of the use of elastomer granules (virgin and from used tires) as filling in third-generation artificial turf.* Report prepared for ADEME/ALIAPUR/Fieldturf Tarkett. Note: The terms "lower" and "higher" refer to the comparison with tire crumb.

[g] Dye, Christian, A. Bjerke, N. Schmidbauer, S. Manø. 2006. *Measurement of Air Pollution in Indoor Artificial Turf Halls.* Trondheim, Norway: Norwegian Pollution Control Authority/Norwegian Institute for Air Research. Report #NILU OR 03/2006. TA number: TA-2148/2006. ISBN number 82-425-1716-9. Note that in this study, phthalates measured in airborne dust at a TPE field were found to be lower at one time, and higher at another time, compared with levels measured at a tire crumb field.

[h] Plants can produce some substances that are classified as VOCs. However, based on currently available information, the plant-based materials used in infill are not expected to pose concerns related to VOCs. PAHs can be taken up by plants from ambient pollution in some cases.

[i] Toxics Use Reduction Institute. 2019. "Artificial Turf Infill: Laboratory Testing Results: PAHs." Fact sheet available at www.turi.org/Our_Work/Community/Artificial_Turf/PAH_Test_Results. TURI contracted with the Icahn School of Medicine at Mount Sinai to conduct limited testing to supplement information available in existing literature.

When researching turf options, communities should evaluate materials carefully and may wish to require additional testing to ensure they have considered the full range of chemicals. Existing tests generally apply only to the sample on which they were conducted, so it is important to obtain data on the specific product in question.

Environmental Concerns

Environmental concerns include loss of wildlife habitat and contaminated runoff into the environment. A study by the Connecticut Department of Environmental Protection identified concerns related to a number of chemicals in stormwater runoff from artificial turf fields. These include both metals and organic compounds. They noted high zinc concentrations in stormwater as a particular concern for aquatic organisms. They also noted the potential for leaching of high levels of copper, cadmium, barium, manganese and lead in some cases. The top concerns identified in the study were toxicity to aquatic life from zinc and from whole effluent toxicity (WET).[57] WET is a methodology for assessing the aquatic toxicity effects of an effluent stream as a whole.[58] In another example, a study found that leachate from several artificial turf systems was toxic to aquatic organisms.[59]

Another environmental concern is migration of synthetic particles into the surrounding environment. Both infill particles and broken synthetic grass fibers do not stay limited to the boundaries of the artificial turf field. Photographic evidence collected by community members in Massachusetts show broken pieces of artificial grass fibers widely dispersed in environments surrounding artificial turf fields. Field maintenance protocols provide for periodic addition of infill to replace infill lost from the field in the course of play, further demonstrating that not all infill particles remain in place within the field. With growing concern about global microplastic pollution, some communities are working actively to reduce the amount of plastic they introduce into the environment. Little or no research has been conducted on ways in which dust and broken particles from artificial turf fields may contribute to microplastic pollution in the environment.

Acrylic-coated sand particles, according to the manufacturer, pose less risk of migrating into waterways compared with other infills because they do not float; however, they could still generate dust that may move offsite. To the extent that particles migrate off the original field site and enter water resources, there could be concerns about whether sedimentary organisms could incorporate these materials and whether they could enter the food chain in this way.

Disposal of the synthetic materials, including the infill and the shock pad, poses an additional concern. Some synthetic materials may be reusable one or more times, while others may have to be disposed of in a landfill or through incineration when the field is due for replacement. RIVM notes that it may be possible to use waste material from a replaced artificial turf field in some other sporting applications, but also notes that due to the degradation of the material over time, this will not always be possible. RIVM

also notes that the substructure elements of an artificial turf field may need to be cleaned prior to recycling, if they are contaminated with any chemicals that have leached from infill. For the limited set of infills it analyzes, RIVM assumes an average 10 year service life for artificial turf fields and assumes that the infill materials are not reused on additional fields.[60]

Artificial Turf and Heat Stress

In sunny, warm weather, artificial turf can become much hotter than natural grass, raising concerns related to heat stress for athletes playing on the fields.[61] Research indicates that all artificial turf reaches higher temperatures than natural grass,[62] although some infill materials may reach higher temperatures than others.

A report by the New York State Department of Environmental Conservation found that surface temperatures on an artificial turf field were 35ºF to 42ºF higher than those on natural grass.[63]

Another study found that the highest temperature measured on artificial turf was 60.3ºF greater than that observed on natural grass.[64]

In another study, artificial turf fibers reached temperatures of 156ºF under direct sunlight, while the crumb rubber infill reached 101ºF.[65]

Measurements taken by sports managers at Brigham Young University found that the surface temperature of artificial turf was 37ºF higher than asphalt and 86.5ºF hotter than natural turf. The hottest surface temperature recorded during the study was 200ºF on a 98ºF day. Even in October, the surface temperature reached 112.4ºF.[66]

Irrigation can lower field temperature for a short time. A study by Penn State's Center for Sports Surface Research found that frequent, heavy irrigation reduces temperatures on artificial turf, but temperatures rebound quickly under sunny conditions.[67] Another study found that irrigation could lower temperatures by 10 to 20 degrees for a period of at least 20 minutes.[68] Another found that irrigation lowered the surface temperature from 174ºF to 85ºF; however, the temperature rebounded to 164ºF after 20 minutes.[69]

Heat-related illness can be a life-threatening emergency. Experts note that athletic coaches and other staff need to be educated about heat-related illness and understand how to prevent it, including cancelling sport activities when appropriate.[70] In one example, a number of students developed heat-related illness after band practice on a new artificial turf field.[71]

Heat can also affect chemical emissions. For example, one study expressed concern about PAH emissions from tire crumb at elevated temperatures. [72]

Additional information on heat is available in TURI's website.[73]

Injuries

Injury rates can be affected by a variety of factors, including the type and condition of the playing surface as well as equipment used and type and level of sport. Studies show variable outcomes in the rates and types of injuries experienced by athletes playing on natural and on artificial turf.[74]

One particular concern is increased rates of turf burns (skin abrasions) associated with playing on artificial turf. For example, a study by the California Office of Environmental Health Hazard Assessment found a two- to three-fold increase in skin abrasions per player hour on artificial turf compared with natural grass turf.[75] These study authors noted that these abrasions are a risk factor for serious bacterial infections, although they did not assess rates of these infections among the players they studied.

Additional information on injuries is available in TURI's website.[76]

Current Federal and State Studies on Artificial Turf and Tire Crumb

As noted above, a number of existing studies have examined the chemicals present in artificial turf, with a particular focus on tire crumb. Some of these studies include a risk assessment, in which an effort is made to estimate the number of cases of disease that could result from exposure to a subset of the chemicals found in tire crumb.

After reviewing the studies, federal and state officials have identified a need for additional information. Two current studies are described here.

California Office of Environmental Health Hazard Assessment

In 2015, the California Office of Environmental Health Hazard Assessment (OEHHA), an office within the California Environmental Protection Agency, began a new study of the potential health effects of exposure to artificial turf as well as playground mats made from recycled waste tires. The study includes analyses of samples of new and used artificial turf and playground mats; the development of exposure scenarios; and the development of a risk assessment based on this information. OEHHA has sampled more than 30 fields in a range of climate regions within California, including both new and old fields.[77] OEHHA is also examining the range of routes by which players and bystanders can be exposed to chemicals found in the artificial turf materials, including through skin contact, breathing, and ingestion. As part of this effort, OEHHA has conducted a survey of both child and adult athletes to learn more about whether they report getting infill materials on their skin, in their eyes, and/or in their mouths during the course of play.[78]

In the future, OEHHA may also examine people's actual exposures through measurement of biological specimens or use of personal monitors.[79]

Research by federal agencies

Three federal agencies are also engaged in an assessment of potential health effects of exposure to artificial turf. The agencies working on the study

are the US EPA, the Consumer Product Safety Commission (CPSC), and the Agency for Toxic Substances and Disease Registry (ATSDR) within the Centers for Disease Control. As background on the need for this study, EPA noted that "limited studies have not shown an elevated health risk from playing on fields with tire crumb, but the existing studies do not comprehensively evaluate the concerns about health risks from exposure to tire crumb."[80] EPA further states, "While this effort won't provide all the answers about whether synthetic turf fields are safe, it represents the first time that such a large study is being conducted across the U.S."[81]

In this project, the federal agencies are working to identify chemicals of concern found in tire crumb, and gain a better understanding of how people are exposed to tire crumb on playing fields and in playgrounds. The study has four components: a literature review and analysis of gaps in current knowledge; a tire crumb characterization study; a sports turf exposure characterization study; and a playground study.[82]

The agencies have issued summary documents based on the work they completed in 2016, including a summary of all the literature that was reviewed and a detailed spreadsheet showing information on which chemicals were examined in each study.[83] These are useful resources for people interested in learning more about the studies that have been conducted to date.

Among other information, the federal agencies' preliminary report on their work provides an overview of knowledge gaps about tire crumb used in playing surfaces. For example, with regard to characterizing tire crumb materials, there are gaps related to chemical characterization, emissions assessments, microbial assessments, bioaccessibility, and variability.[84] For example, EPA notes that there is a lack of studies that measure a wide range of tire crumb samples and consider the full range of chemicals that can be found in tires. Regarding emissions, EPA notes that "few laboratory-based studies have investigated VOC and SVOC emissions from synthetic fields and playgrounds under different temperature conditions," and those studies that do exist have considered only a limited set of chemical emissions. Regarding bioaccessibility (the likelihood that the human body will take up the chemicals present in the material), there is a lack of studies that "systematically measure a wider range of metal and organic chemical constituents, using multiple simulated biological fluids, and across a large range of tire crumb rubber samples." Finally, EPA notes that "most studies characterizing tire crumb rubber from synthetic fields and playgrounds in the United States have been relatively small, and restricted to a few fields or playgrounds. Measurements for samples collected from a wider range of tire recycling plants, synthetic fields, and playgrounds across the United States is lacking."

Additional gaps exist with regard to other important areas of study. For example, with regard to characterizing exposure and risk, there are gaps related to exposure factors, dermal or ingestion exposures, exposure through broken skin or through eyes, and more. EPA notes that while a number of studies have examined possible exposures through inhalation, "more limited information is available for understanding dermal and ingestion exposures." EPA also notes that "little information is available on the potential for increased exposures via broken skin (i.e., due to cuts and scrapes) and through ocular fluids," and that few studies have examined the potential cumulative effects of exposures through multiple routes, including inhalation, ingestion, and skin exposure.

Other parts of the federal agencies' work are still in progress at the time of publication of this report. EPA and CDC/ATSDR have completed the collection and analysis of samples for the exposure and tire crumb characterization parts of the study, and the draft report is now undergoing technical peer

review, according to EPA's website, updated September 2018.

In addition, CPSC has completed a study of how children interact with recycled tire materials on playgrounds. CPSC used a combination of focus groups, field observations, and a national survey of parents and child-care providers to collect information on children's behavior when playing on playground surfacing made from recycled tires or other materials. CPSC focused in particular on the behavior and experience of toddlers on playgrounds. Among other findings, CPSC noted that children "may be commonly exposed to rubber surfacing materials in various ways, such as chewing the materials and being scraped by them." They noted concerns including children mouthing and chewing rubber surfacing materials; stains from rubber surfacing left on children's skin and clothing; children picking up rubber mulch; children being exposed through bare feet; and children eating snacks at playgrounds. The CPSC found that the study findings raise concerns that deserve further investigation.[85]

What is a Risk Assessment?

Many existing studies on the use of tire crumb in artificial turf are quantitative risk assessments. Risk assessment is a methodology used by researchers to estimate the number of cases of disease that could result from anticipated exposure. To develop a risk assessment, researchers may bring together information on chemical toxicity, level of exposure, route of exposure, expected ages at which exposure may occur, expected duration of exposure, and expected ways in which the body may absorb and process the chemicals. Since risk assessments often consider just a subset of the chemicals present in artificial turf, they may not present a complete picture. In addition, a number of assumptions have to be made in the course of the assessment, and the final result is an estimated number of cases of disease (e.g., an expected number of cancer cases per million people exposed). This number may be used in discussions about levels of risk that are considered acceptable.

The Toxics Use Reduction approach does not rely on quantitative risk assessments; rather, the focus is on reducing or eliminating toxic chemical use when possible.

New Regulatory Initiatives in Europe

The European Union regulates chemicals under its Registration, Evaluation and Authorisation of Chemicals (REACH) regulation. The Netherlands has developed a proposal under REACH to regulate the presence of PAHs in sports turf infills.[86] Specifically, the proposal would limit the level of eight PAHs in sports turf infills, as well as in materials used in loose form on playgrounds. The proposed restriction is based on a finding that the EU's current exposure limits for these materials are not sufficiently protective. The proposed restriction would limit the sum of the eight PAHs to 17 mg/kg in granules or mulches used as infill or as playground surfacing in order to reduce the estimated cancer risk for exposed individuals to 2.6×10^{-6} (2.6 per million).[87] The proposed restriction was developed in response to concerns about PAHs in waste tires but would apply to any alternative material as well. This is the first step in a multi-stage regulatory and consultation process. If there is agreement on the restriction, the estimated timeline is that it would be adopted in 2020.[88]

Laboratory Testing of Artificial Turf

A number of communities have asked TURI what types of information they should gather as they make decisions about artificial turf fields. All the issues noted above are relevant for decision making, but confusion often arises around the testing that may be conducted on turf infill and grass blades.

In general, manufacturers are able to provide test data covering a number of metals of concern. Manufacturers often provide a comparison between this information and the standards provided in the European Toy Safety Standard. Communities may choose to order their own tests on metal contents as well.

Less information tends to be available on other, non-metal chemicals that may be present in either the infill or the grass blades. Therefore, communities may wish to either conduct their own testing or request test results from the vendor on these other chemicals. For example, it may be useful to ask the vendor for data on VOCs, SVOCs, and PAHs present in the product.

Safer Alternative: Natural Grass

Natural grass fields can be the safest option for recreational space, by eliminating many of the concerns noted above. Grass fields may be maintained organically or with conventional or integrated pest management (IPM) practices. Organic turf management eliminates the use of toxic insecticides, herbicides and fungicides.


Photo credit: Adam Anulewicz

Forest Park, Springfield, MA, 2018.

Natural grass can reduce a field's overall carbon footprint by capturing carbon dioxide. A natural grass field can also provide a number of ecosystem services, such as providing habitat for invertebrates and microorganisms, reducing the heat island effect in urban areas, and helping to control flooding, among others.

Table 3 shows a broad comparison between artificial turf and natural grass, including conventionally and organically managed grass. As shown in the table, artificial turf can pose chemical hazards related to chemicals either present in the surfacing material or applied to the surface. Cleaners, disinfectants and even herbicides may sometimes be applied to the artificial turf surface as well. Natural grass, on the other hand, only contains whatever is already in the ambient environment and generally does not include polymers, rubber and plastic additives, or respiratory hazards such as zeolite. Conventionally managed natural grass may be treated with synthetic pesticides or fertilizers; organically managed natural grass builds soil health, making it unnecessary to apply chemical treatments.

Table 3: Comparing artificial turf with natural grass				
Category	**Subcategory**	**Artificial turf**	**Natural grass – conventional**	**Natural grass – organic**
Chemicals	**Present in surface**	Polymers, additives; respiratory hazards, e.g., zeolite	Ambient environmental exposures only	
	Applied to surface	Cleaners, disinfectants, herbicides	Synthetic pesticides, fertilizers	Soil health built through aeration, proper mowing practices, organic soil amendments, and other approaches
Other health hazards	**Heat**	Higher	Lower	
	Risk of skin abrasions and infections	Higher	Lower	
	Other injuries	Variable injury patterns		
Other environmental considerations	**Ecosystem services**	None	Habitat for a range of organisms; carbon fixation; water/flood control; reduction of heat island effect in urban areas	
	Migration of materials	Particles of infill & artificial grass blades can migrate into environment	Possible fertilizer runoff or pesticide drift	n/a
	Water use	Irrigation may be used to lower temperature	Irrigation may be used to support grass growth	Irrigation may be used to support grass growth; organic management reduces irrigation needs by supporting root development

Organic Management of Recreational Field Space

Organic management of a recreational field space requires a site-specific plan to optimize soil health and minimize long-term costs. Over time, a well-maintained organic field is more robust for recreational use due to a stronger root system than that found in a conventionally managed grass field. Water needs also decrease over time. Key elements of organic management include the following steps.[89]

- **Field construction**: Construct field with appropriate drainage, layering, grass type, and other conditions to support healthy turf growth. Healthy, vigorously growing grass is better able to outcompete weed pressures, and healthy soil biomass helps to prevent many insect and disease issues.
- **Soil maintenance**: Add soil amendments as necessary to achieve the appropriate chemistry, texture and nutrients to support healthy turf growth. Elements include organic fertilizers, soil amendments, microbial inoculants, compost teas, microbial food sources, and topdressing as needed with high-quality finished compost.
- **Grass maintenance**: Maintain turf health through specific cultural practices, including appropriate mowing, aeration, irrigation, and over-seeding. Address trouble spots through composting and re-sodding where necessary.

It is important to note that organic turf management requires proper training. Conventional turf management may follow a similar protocol each year; organic turf managers make adjustments based on changing conditions.

Installation/Maintenance Costs: Comparing Artificial Turf with Natural Grass

In analyzing the costs of artificial vs. natural grass systems, it is important to consider full life cycle costs, including installation, maintenance, and disposal/replacement. Artificial turf systems of all types require a significant financial investment at each stage of the product life cycle. In general, the full life cycle cost of an artificial turf field is higher than the cost of a natural grass field.

Cost information is available through university entities, turf managers' associations, and personal communications with professional grounds managers. Information is also available on the relative costs of conventional vs. organic management of natural grass.

Installation

According to the Sports Turf Managers Association (STMA), the cost of installing an artificial turf system may range from $4.50 to $10.25 per square foot. For a football field with a play area of 360x160 feet plus a 15-foot extension on each dimension (65,625 square feet), this yields an installation cost ranging from about $295,000 to about $673,000. These are costs for field installation only, and full project costs may be higher. Costs for a larger field would also be higher. A range of choices in materials and underlayments can influence the total cost of the field.

In one site-specific example, information provided by the town of Natick, Massachusetts, shows that the full project budget for the installation in 2015 of a new artificial turf field (117,810 square feet), along with associated landscaping, access and site furnishings, totaled $1.2 million.[90]

For natural grass, installation of a new field may not be necessary. For communities that do choose to install a new field, costs can range from $1.25 to $5.00 per square foot, depending on the type of field selected. For the dimensions noted above, this would yield an installation cost ranging from about $82,000 to about $328,000.[91]

Maintenance

Maintenance of artificial turf systems can include fluffing, redistributing and shock testing infill; periodic disinfection of the materials; seam repairs and infill replacement; and watering to lower temperatures on hot days. Maintenance of natural grass can include watering, mowing, fertilizing, replacing sod, and other activities. In both cases, specialized equipment is needed. Communities shifting from natural grass to artificial turf may need to purchase new equipment for this purpose. According to STMA, maintenance of an artificial turf field may cost $5,000 to $8,000 per year for materials and 300 to 500 hours of labor per year. These estimates are higher for artificial turf fields used for multiple sports. Maintenance of a natural grass field may cost $4,000 to $14,000 per year for materials plus 250 to 750 hours of labor.[92]

Organic turf maintenance can be cost-competitive with conventional management of natural grass. One study found that once established, an organic turf management program can cost 25% less than a conventional turf management program.[93]

Fifteen acres of playing fields in Marblehead, MA are managed organically. Annual maintenance costs are $2,400–$3,000 per 2-acre playing field, not including mowing costs. Mowing costs for a 2-acre field were estimated in 2010 to be $10,000 annually. Thus, total maintenance costs per 2-acre field are $12,400 to $13,000 annually (or $0.14 to $0.15 per square foot per year).[94]

Disposal/replacement

Artificial turf also requires disposal at the end of its useful life. STMA estimates costs of $6.50 to $7.80 per square foot for disposal and resurfacing.[95] Those estimates yield $426,000 to $512,000 for a

65,625 square foot field and $552,000 to $663,000 for an 85,000 square foot field.

Annualized costs

In 2008, a Missouri University Extension study calculated annualized costs for a 16-year scenario. The calculation included the capital cost of installation; annual maintenance; sod replacement costing $25,000 every four years for the natural fields; and surface replacement of the synthetic fields after eight years. Based on this calculation, a natural grass soil-based field is the most cost effective, followed by a natural grass sand-cap field, as shown in Table 5.[96] Another study, conducted by an Australian government agency, found that the 25-year and 50-year life cycle costs for artificial turf are about 2.5 times greater than those for natural grass.[97]

Planning over time

Each municipality or institution will face its own considerations as it works to develop plans for athletic fields. Some municipalities are working from a baseline of an existing, poorly-maintained grass field, or a field with poor drainage, and may wish to research options for upgrading these existing resources. In planning for the medium term, it is necessary to have a maintenance plan, whether the field is grass or artificial. For an artificial turf field, the community also needs to plan for disposal.

Summary

In summary, when the full product life cycle is taken into account, natural grass is likely to be more cost effective than artificial turf. Organic management of natural grass can further lower costs over time by building healthy soil and robust root systems. When assessing the cost of any option, whether natural grass or artificial turf, it is also important to note that there can be cost gradations depending whether a basic or a premium field is needed. More detailed cost information is also available on TURI's website.[98]

Organic Management of Playing Fields: Springfield, MA

The city of Springfield, Massachusetts, manages many of its sports fields organically. According to the Springfield Parks Department, organic management has improved the overall condition of these fields. Many hours of both formal and informal sports play occur on these fields, and there are few or no cancellations due to weather-related field conditions.[99]

Forest Park, Springfield, MA, 2018.

The consultant working with Springfield was able to provide TURI with cost figures for the first three years of organic management. The cost was $1,740/acre in the first year, $1,245/acre in the second year, and $1,110/acre in the third year. Thus, maintenance costs decreased each year as the health of the soil and vegetation improved.[100]

The consultant was also able to provide an estimate of the hours of play on one of the organically managed fields. The field has 650 scheduled hours annually. In addition to this, physical education classes are held on the field and there is an estimated 100 hours of non-programmed use. The consultant estimated that this adds up to a total of about 1,000 hours of field use per year.[101]

Conclusions

Artificial turf poses a number of health and environmental concerns. Those communities that have decided to install artificial turf are encouraged to make careful choices among the materials available to them. This is likely to include requiring some additional testing to get information on organic compounds as well as metals. Communities should bear in mind that existing tests apply only to the sample on which they are conducted, and materials used in artificial turf may vary widely in composition. From an environmental and health standpoint, organically managed natural grass is a safer choice for sports fields. When the full product life cycle is considered, organically managed natural grass also offers lower costs over time.

Glossary of Acronyms

ATSDR	Agency for Toxic Substances and Disease Registry
CPSC	Consumer Product Safety Commission
EPA	US Environmental Protection Agency
EPDM	Ethylene propylene diene terpolymer
FDA	US Food and Drug Administration
IPM	Integrated pest management
NBI	Norwegian Building Institute
OEHHA	California Office of Environmental Health Hazard Assessment
PAHs	Polyaromatic hydrocarbons
$PM_{2.5}$	Particulate matter with diameter less than 2.5 micrometers
REACH	European Union's Registration, Evaluation and Authorisation of Chemicals
RIVM	National Institute for Public Health and the Environment (Netherlands)
RSLs	Restricted Substances Lists
SBR	Styrene Butadiene Rubber
STMA	Sports Turf Managers Association
SVOCs	Semi-volatile organic compounds
TPE	Thermoplastic elastomer
TUR	Toxics Use Reduction
TURI	Massachusetts Toxics Use Reduction Institute
TVOCs	Total volatile organic compounds
VOCs	Volatile organic compounds
WET	Whole effluent toxicity

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TOWN OF ARLINGTON
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ARLINGTON CONSERVATION COMMISSION

Artificial Turf Field Information Considered for the AHS Notice of Intent

While reviewing the AHS NOI, the Arlington Conservation Commission became aware of a proposal for an artificial turf field in Sharon, MA, that was under review by the Sharon Conservation Commission. The Sharon Conservation Commission shared all of its documents with the Arlington Conservation Commission, and can be accessed through this google drive link.

If you have trouble accessing the google drive with the Sharon Conservation Commission materials, please contact Conservation Agent Emily Sullivan at esullivan@town.arlington.ma.us or 781-316-3012.

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July 9, 2020

Arlington Conservation Commission
Department of Planning and Community Development Town of Arlington
730 Massachusetts Avenue Annex
Arlington, MA 02476

Dear Commissioners,

Thank you for the opportunity to to provide comment prior to your vote on the Arlington High School building project. We are aware that you have received information and commentary from our Committee Chair, Jeff Thielman, as well as documentation from our design team. This letter is to give an overview of the educational value of the artificial turf surfaces. Matthew Janger will also be attending the commission meeting to answer questions.

The overall design of the high school is driven by the Educational Program and a set of Guiding Principles (attached to this letter). These emphasize a balance among educational programs, the creation of usable outdoor spaces, and sustainability. The high school is on a constrained site and the plan was designed to provide the maximum amount of outdoor use. The inclusion of the two additional turf, multi-purpose fields should be seen in that context.

The main benefits of the turf field include improved functionality for multiple athletic uses. Turf fields are also associated with fewer injuries. Because the turf can be cleared and used shortly after rain or snow, it significantly extends the usable season and time, allowing Physical Education (PE) and athletics to move outside earlier and more often. By consolidating the use of turf fields and lights at the high school, we create a flexible multipurpose facility that allows for greater flexibility and lower impact on the community overall. These main benefits run through the discussion below.

Our Guiding Principles include providing “outdoor connections, gathering places, and classrooms.” For the Physical Education program, the playing fields are used for outdoor classes all year round. The turf fields provide outdoor activities and space for classes that would otherwise have more limitations if held in a gym. Because they can be used under wider weather conditions, this substantially extends these opportunities. This has programming impacts for other classes, as we often use the gym spaces to support other activities.

Physical Education is a 4-year requirement and students choose from a wide array of options including climbing, winter survival, backpacking, yoga, mindfulness, personal fitness, weight lifting, walking, and team sports. Students currently enroll in Physical Education beyond the minimum graduation requirements.

The interscholastic Athletics program is also an important part of our educational mission at the high school. Athletic participation is shown to enhance individual and collective growth during high school. Arlington High School's 30 teams make extensive use of town fields for practices and games. The consolidation of the primary fields and practice facilities at the high school will have a positive impact on safety, communication, and effectiveness. Currently, Varsity and JV teams have to play on different fields which affects both supervision by coaches and the availability of the Athletic Trainer. The new facility will support play in the same area rather than at two different fields. This will mean that the Athletic Trainer can support multiple games and practices in one location, which provides more on-site care of students who are injured. The rapid recovery of the artificial turf reduces the impact of inclement weather on practices and games, resulting in fewer cancellations of games after rain events.

Expanding the multi-purpose turf fields at the high school site will not only improve options for students at the high school level, but it will also improve options for youth sports across the community. These groups are eager to use the turf and will also have increased access to green spaces and other playing fields as the high school concentrates its activities.

As noted above, the athletic field facilities are part of a strategy to expand usable outdoor spaces for classes and recreation. The current plan will create an attractive landscape surrounding the building and multi-use outdoor spaces. The designl plan includes a large enclosed green area between the STEAM and Humanities buildings. Plans for this space include a work area for makerspace projects, outdoor arts areas, environmental science gardens, and outdoor classrooms. Outside the Performing Arts building will be an outdoor amphitheater for performances, events, classes, and outdoor study. A third courtyard opens into the cafeteria, creating a space for eating, class, study, and display.

The Arlington High School Building Committee has taken the stewardship of the site and environment into account from the beginning. In the context of the overall project's educational goals, the selection of artificial turf fields should be seen in that overall context of sustainability, balance, and access to the outdoors that runs through our Guiding Principles.
We look forward to the opportunity to answer questions and discuss this further.

Sincerely,

Dr. Kathleen Bodie, Superintendent

Dr. Matthew Janger, Principal

Enclosure: Educational Program: Guiding Principles

Guiding Principles

In anticipation of the need to rebuild the high school building, Arlington High School (AHS) administration and faculty have spent the last 4 years visiting schools, reflecting, and gathering our thinking on the future of instruction and the building we will need to support this future. Departments, interest groups formed around areas of focus such as school climate and culture, outside space and student leadership, and affiliated community groups were invited to reflect and create draft reports on their current and future practices and needs. In addition, the high school and district engaged in an ongoing evidence-based strategic planning and goal setting process to create our annual School Improvement Plan (attached).

As a result, we were well prepared as a community to engage in the process of visioning with David Stephen of New Vista Design. Each department and many functional groups produced statements of educational philosophy, current practices, and future needs. We held a series of 3 community forums to gather input. We also held a session with the faculty as a whole to reflect on the work we have done so far. An Educational Visioning Group comprising staff, administration, students, and community members met for a series of 3 workshops to synthesize this feedback and input into an educational vision, as well as guidance on design patterns to support that vision.

We found strong community consensus for the following Guiding Principles to govern the design of the renovated and/or new Arlington High School facility.

> At its heart, the renovated and/or new Arlington High School facility must support the best of what AHS is doing now, as well as allow the development and implementation of effective and innovative future teaching and learning practices. It must honor the enduring importance of teacher professionalism in supporting expertise in the academic disciplines and relationships in learning communities, as well as flexibly support interdisciplinary, collaborative, connected, project-based, and personalized learning.
>
> AHS is committed to teaching all children and the whole child. We believe that the future of education in Arlington requires:
>
> 1. *Teacher professionalism* - rich classroom and departmental work spaces to support teacher expertise and relationships in learning communities
> 2. *Inquiry and collaboration* - an interdisciplinary learning commons with research tools, technology, gathering, and breakout spaces to support teaching and learning in the future
> 3. *Creating and creativity* - specialized and distributed spaces and technology for hands-on and applied learning, including spaces and technology for making, displaying, and storage of work
> 4. *Support for students' social-emotional needs and social-emotional learning* - centralized and distributed support spaces and personnel, access to nature, and welcoming space
> 5. *Inclusive and engaged community* - welcoming spaces where we come together as a school and that also serve as a community resource

The following additional principles developed through the visioning process should also guide the design of the new facility:

Teach the Whole Child

- Foster personalization, connection, and ownership
- Meet the varied learning needs of students
- Support students in finding their place/passion
- Extend learning opportunities beyond classroom walls
- Promote social-emotional learning
- Be fun and engaging

Support Inquiry-Based Learning and Promote Inventive and Student-Centered Learning

- Provide hands-on STEM and STEAM opportunities
- Encourage project-based learning and design thinking
- Include applied and authentic learning
- Support interdisciplinary connections
- Promote visible learning

Foster School Community

- Provide accessible and navigable spaces that build community
- Locate Library Learning Commons as heart of school
- Create learning neighborhoods of common Interest
- Support interdisciplinary and collaborative learning
- Promote social-emotional health and wellness
- Encourage communication and collaboration

Envision School as Community Hub

- View school as hub of learning, activity, and engagement
- Support community access and use
- Employ a design aesthetic and sensibility of its time
- Embody a sense of history, character, and durability
- Reflect the history and aesthetic of Arlington/New England

Provide Physical and Programmatic Flexibility

- Adapt to varied and unknown future needs and uses
- Provide flexibility for 21st Century teaching and learning
- Support technology integration and evolution
- Remain flexible and future proof

Promote Sustainability

- Ensure energy efficiency
- Promote social responsibility
- Remain practical and cost effective
- Employ building as teacher
- Provide outdoor connections, gathering places, and classrooms

Conservation Commission Requests for Information #7

Re: Arlington High School Expansion SCI File #17211.00

RE: Conservation Requests July 9, 2020 Item #7 Climate Change Summary for Turf Fields

At the request of the Conservation Commission, in addition to the heat island analysis provided, the following details other factors in the alternative analysis for selecting turf fields over grassed fields.

For some background on how this alternative was selected, the Arlington High School Building Committee has held public meetings for over three years and many discussions centered on the benefits of installing an artificial turf field (similar to the one currently at the high school stadium) for all other sports. As designed the new artificial turf fields will serve baseball, softball, soccer, lacrosse, and football. This is due to the ability to layout out overlapping sports within the same footprint. Many discussions regarding costs/benefits analysis occurred when the Committee needed to reduce project costs. It was agreed by the 18-person committee that artificial turf fields versus natural grass turf fields are essential for the high school program. The artificial turf, with its superior drainage, will allow for six (6) more weeks of outdoor activity for Arlington students. This benefit was paramount to the educators, parents, and residents of the School Building Committee.

These additional six weeks of outdoor activity also assumes that the grassed fields remain in playable condition for the entire fall and spring season. In actuality, the grassed fields typically become muddied and bare – causing erosion and siltation – most season due to challenging weather and over-use for that surface versus student activity needs. The selection of turf fields will remove that siltation source to the resource areas.

Regarding the turf meeting ecological standards, the project will now meet the specifications of the New York State Standards per the request of the Commission, the strictest guidelines that are available. Additionally, the project meets all the MA DEP Performance standard for how the turf fields would affect the waters and wetland plantings, as there are no studies nor data available showing that any runoff from turf fields has a detrimental affect on those resources for us to meet. The following are how the Turf Fields (and the overall project as previously illustrated) meets the SMP standards:

- Standard 1 – No new, untreated discharges associated with the synthetic turf field
- Standard 2 - Peak rate attenuation – No increase in peak rates
- Standard 3 – Recharge – None at synthetic turf due to contaminated groundwater and soil (project is a redevelopment of a contaminated site with a hard environmental cap below grade); Standard 3 met overall where infiltration is allowed.
- Standard 4 – Water quality:

  TSS reduced due to synthetic turf field providing vertical infiltration and filtering through the turf into drainage pad layer, which discharges into the field's subsurface detention basins. Also the size of the rubber granules is larger than sediment; these granules are filtered and / or covered by the synthetic turf fibers preventing migration of these granules into the trench drain surface collection system and the downgradient subsurface detention system. Runoff flows into the structured voids that are wrapped with drainage fabric and then into the surrounding stone, being stored in both the voids and the stone.

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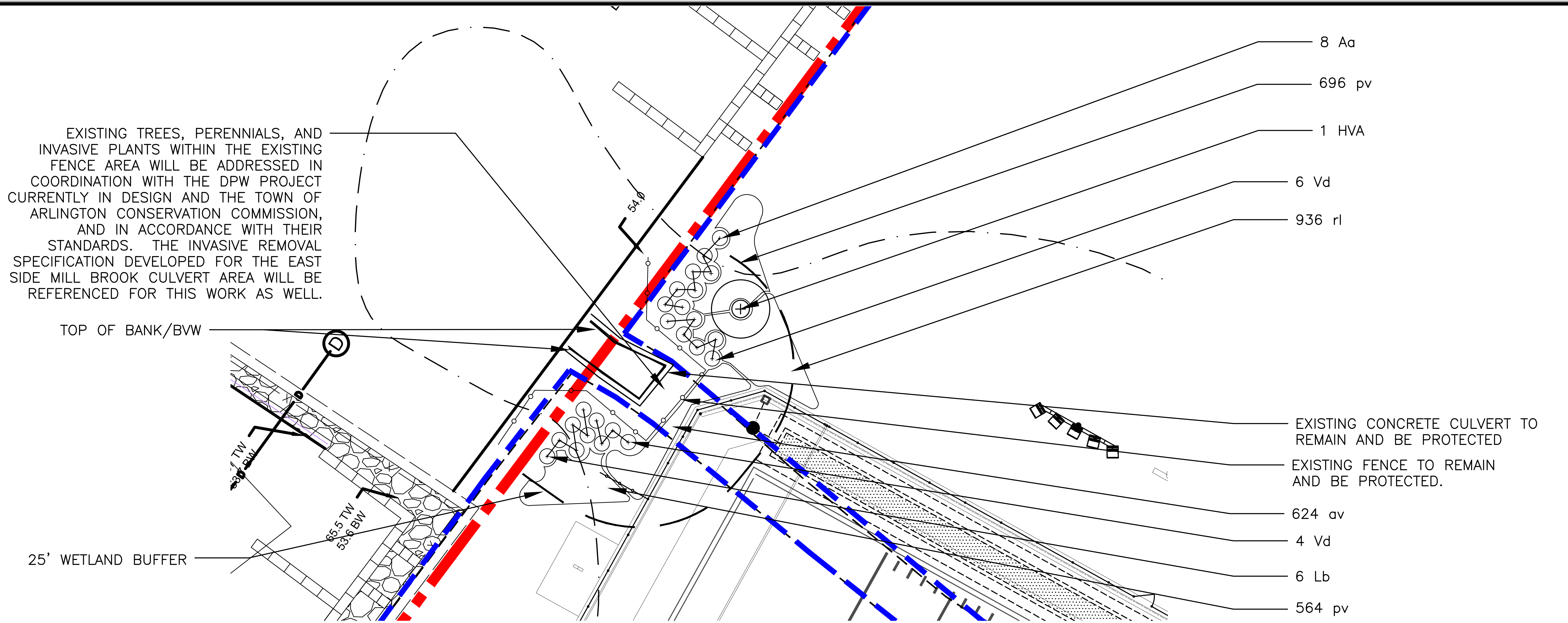
While it is often said that Owners add infill through the life of these fields due to migration of infill, this perception is not factual as infill is rarely ever added, contrary to popular belief. Most fields are installed with one to two surplus “super-sacks” of infill for infill loss and migration. This material is mostly used to level out the surface in front of goals and at penalty shot area, typically a five-gallon bucket here and there during a season. Sometimes infill is added due to settlement, caused by poor maintenance practices, but this is rare due to improved maintenance practices. A properly maintained field is unlikely to require even a small portion of a single super-sack of infill though its life. There will be some infill which migrates off the field in players socks and shoes due to static cling, but this quantity is again very, very small.

Testing of US manufactured passenger tires under testing using EN 71/3 indicates SBR passes this water quality requirement and ASTM F 3188 (toy standards). Several non-USA manufacturer samples did not pass. Our specification requires only US passengers be used in our infill.

- Standard 5 – Not Applicable
- Standard 6 – Not Applicable
- Standard 7 – Redevelopment – Not Applicable (meets all standards)
- Standard 8 - Construction Period Pollution Prevention and Erosion and Sedimentation Control - Included with overall project
- Standard 9 - Operation and Maintenance Plan – A basic program was provided however, the selected vendor is required to provide a product specific maintenance program
- Standard 10 - Prohibition of Illicit Discharges - None



PROPOSED PLANT LIST					
TREES, SHRUBS,PERENNIALS					
SYMBOL	BOTANICAL NAME	COMMON NAME	QUANTITY	SIZE	REMARKS
HVA	Hammamelis virginiana	Common Witch hazel	1	5-6 FT HT	B&B
Aa	Aronia arbutifolia	Red Chokeberry	8	3 GAL	CONTAINER
Lb	Lindera benzoin	Spicebush	6	5 GAL	CONTAINER
Vd	Viburnum dentatum	Arrow-wood Viburnum	10	5 GAL	CONTAINER
av	Andropogon virginicus	Broom Sedge	624	landscape plugs	4 PER S.F.
pv	Panicum virgatum	Switch Grass	1260	landscape plugs	4 PER S.F.
rl	Rudbeckia laciniata	Green Coneflower	936	landscape plugs	4 PER S.F.

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Arlington High School

CONSERVATION COMMISSION PLANTING IMPROVEMENTS

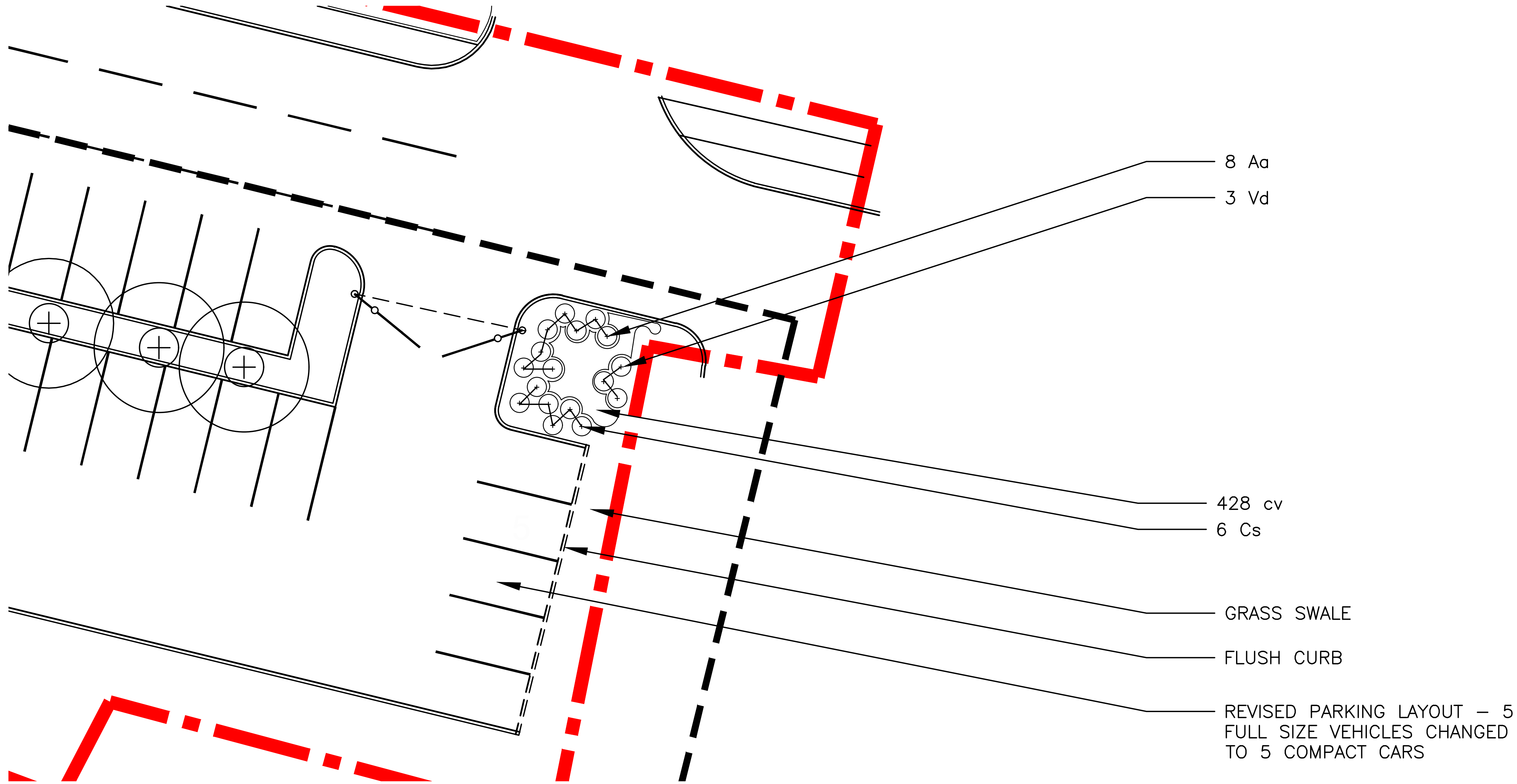
LANDSCAPE PLAN

WEST SIDE CULVERT PLANTING CHANGES

SCALE: NTS DATE: 7.14.2020 DRAWN: CSS CHECKED: CSS

DRAWING NUMBER
1

JOB NUMBER 408417



PROPOSED PLANT LIST					
SHRUBS,PERENNIALS					
SYMBOL	BOTANICAL NAME	COMMON NAME	QUANTITY	SIZE	REMARKS
Aa	Aronia arbutifolia	Red Chokeberry	8	3 GAL	CONTAINER
Cs	Cornus sericea 'Alleman's'	Compact Red Twig Dogwood	6	5 GAL	CONTAINER
Vd	Viburnum dentatum	Arrow-wood Viburnum	10	5 GAL	CONTAINER
cv	Carex vulpinoides	Fox Sedge	428	landscape plugs	4 PER S.F.

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Arlington High School

CONSERVATION COMMISSION PLANTING IMPROVEMENTS

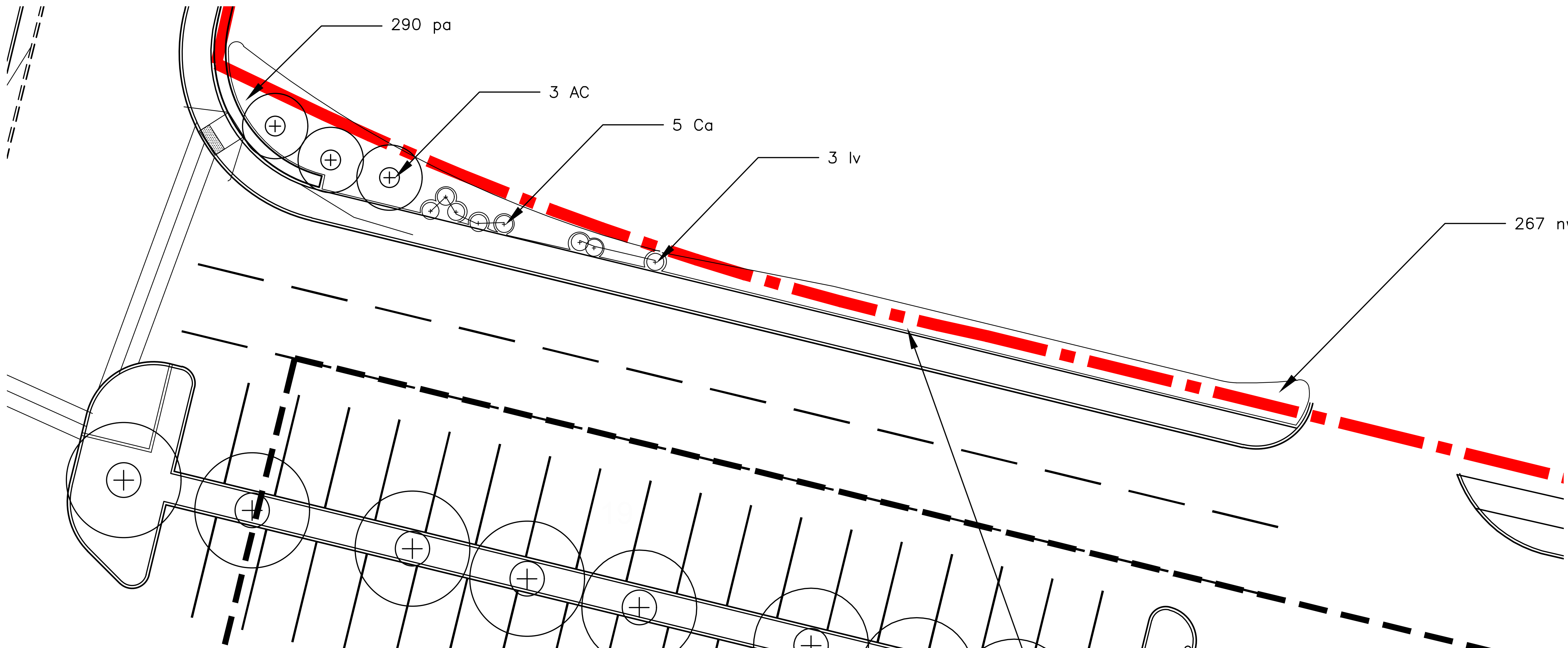
LANDSCAPE PLAN

EAST SIDE PARKING LOT RAIN GARDEN PLANTING CHANGES

SCALE: NTS DATE: 7.14.2020 DRAWN: CSS CHECKED: CSS

DRAWING NUMBER 2

JOB NUMBER 408417



THE AREA AT THE TOP OF THE MILL BROOK BANK AND WITHIN THE PROPERTY LIMITS OF THE ARLINGTON HIGH SCHOOL WILL BE CLEARED OF INVASIVE SPECIES AS PER THE SPECIFICATIONS AND IN COORDINATION WITH THE TOWN OF ARLINGTON CONSERVATION COMMISSION. BITTERSWEET VINE AND JAPANESE KNOTWEED WERE NOTED DURING THE SITE WALK ON 7.14.2020.

A MAINTENANCE REGIME TO ENSURE SUCCESSFUL REMOVAL, AND TO PROTECT AGAINST NEW INVASIVE SPECIES FROM GAINING HOLD WHILE NATIVE PLANTINGS ARE ESTABLISHED WILL BE ENACTED IN ACCORDANCE WITH ARLINGTON CONSERVATION COMMISSION GUIDELINES AND AS DESCRIBED IN THE SPECIFICATIONS.

WITHIN THIS AREA OF EXISTING VEGETATION, PROTECT EXISTING TREES AS DIRECTED BY THE ARLINGTON TREE WARDEN AND THE LANDSCAPE ARCHITECT. DEAD TREES SHOULD BE REMOVED.

PROPOSED PLANT LIST

TREES, SHRUBS, PERENNIALS

SYMBOL	BOTANICAL NAME	COMMON NAME	QUANTITY	SIZE	REMARKS
AC	Amelanchier canadensis	Shadblow Serviceberry	3	7-8 FT	B&B
Ca	Clethra alnifolia 'Ruby Spice'	Ruby Spice Summersweet	54	3 GAL	CONTAINER
Iv	Itea virginica 'Little Henry'	Little Henry Sweetspire	91	3 GAL	CONTAINER
pb	Pennisetum alopecuroides 'Little Bunny'	Little Bunny Fountin Grass	290	1 GAL	18" O.C.
nw	Nepeta 'Walker's Low'	Walker's Low Cat Mint	267	1 GAL	18" O.C.

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Arlington High School

CONSERVATION COMMISSION PLANTING IMPROVEMENTS

LANDSCAPE PLAN

EAST SIDE TOP OF MILL BROOK BANK PLANTING CHANGES

SCALE: NTS DATE: 7.14.2020 DRAWN: CSS CHECKED: CSS

DRAWING NUMBER 3

JOB NUMBER 408417

Conservation Commission Requests for Information #6 &7

Re: Arlington High School Expansion SCI File #17211.00

RE: Conservation Requests July 9, 2020 Items #6 and 7

At the request of the Conservation Commission, this memo responds to items 6 and 7 regarding the turf meeting ecological standards, SMP standards, and how the stormwater system filters infill material. The project will now meet the specifications of the New York State Standards per the request of the Commission, the strictest guidelines that are available. Additionally, the project meets all the MA DEP Performance standard for how the turf fields would affect the waters and wetland plantings, as there are no studies nor data available showing that any runoff from turf fields has a detrimental affect on those resources for us to meet. The following are how the Turf Fields (and the overall project as previously illustrated) meets the SMP standards:

- Standard 1 – No new, untreated discharges associated with the synthetic turf field
- Standard 2 - Peak rate attenuation – No increase in peak rates
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- Standard 4 – Water quality:

  TSS reduced due to synthetic turf field providing vertical infiltration and filtering through the turf into drainage pad layer, which discharges into the field's subsurface detention basins. Also, the size of the rubber granules is larger than sediment; these granules are filtered and / or covered by the synthetic turf fibers preventing migration of these granules into the trench drain surface collection system and the downgradient subsurface detention system. Runoff flows into the structured voids that are wrapped with drainage fabric and then into the surrounding stone, being stored in both the voids and the stone.

  While it is often said that Owners add infill through the life of these fields due to migration of infill, this perception is not factual as infill is rarely ever added, contrary to popular belief. Most fields are installed with one to two surplus "super-sacks" of infill for infill loss and migration. This material is mostly used to level out the surface in front of goals and at penalty shot area, typically a five-gallon bucket here and there during a season. Sometimes infill is added due to settlement, caused by poor maintenance practices, but this is rare due to improved maintenance practices. A properly maintained field is unlikely to require even a small portion of a single super-sack of infill though its life. There will be some infill which migrates off the field in players socks and shoes due to static cling, but this quantity is again very, very small.

  Testing of US manufactured passenger tires under testing using EN 71/3 indicates SBR passes this water quality requirement and ASTM F 3188 (toy standards). Several non-USA manufacturer samples did not pass. Our specification requires only US passengers be used in our infill.

- Standard 5 – Not Applicable

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- Standard 6 – Not Applicable
- Standard 7 – Redevelopment – Not Applicable (meets all standards)
- Standard 8 - Construction Period Pollution Prevention and Erosion and Sedimentation Control - Included with overall project
- Standard 9 - Operation and Maintenance Plan – A basic program was provided however, the selected vendor is required to provide a product specific maintenance program
- Standard 10 - Prohibition of Illicit Discharges - None

P:\Projects\2017\17211.00 Arlington HS (Civil)\Documents\Permitting\Conservation Commission\NOI\Con Com Additional Information\ Item 7 Climate Change Summary for Turf Fields – Perf Standards.doc

Conservation Commission Requests for Information #2

Re: Arlington High School Expansion SCI File #17211.00

RE: Conservation Requests July 9, 2020 Item #2 AURA Analysis (West)

Section 25 – Adjacent Upland Resource Area

C. Alternatives to Work in Adjacent Upland Resource Area. A growing body of research evidence suggests that even "no disturbance" areas reaching beyond 25 feet from wetlands, streams, rivers, and other water bodies may be insufficient to protect many important characteristics and values. Problems of nutrient runoff, water pollution, siltation, erosion, vegetation change, and habitat destruction are greatly exacerbated by activities within 100 feet of wetlands. Thus, work and activity in the Adjacent Upland Resource Area shall be avoided and discouraged and reasonable alternatives pursued.

Only when the Applicant proves through a written alternative analysis that reasonable alternatives are not available or practicable, the Commission may, in its discretion, allow temporary, limited, or permanent disturbance as appropriate and consistent with this Section depending on the characteristics of the Adjacent Upland Resource Area, including but not limited to the following:

(1) slope

- ***The proposed design provides a stabilized slope planted with grasses and a portion with have a turf field.***

(2) soil characteristics

- ***The soils horizon is "B" type soils with a natural grass field that cannot handle sports and functions for more than one season due to the nature of the natural turf.***

(3) drainage patterns

- ***Drainage patterns under proposed conditions are maintained but the stormwater from the turf field will be routed through a stone base and drain system before being conveyed to the new stormwater system as opposed to only an underdrain in the current conditions.***

(4) extent and type of existing native vegetation

- ***The existing surfaces within the AURA are natural grasses, a shed, and some invasives.***

(5) extent and type of invasive vegetation

- ***The top of the existing culvert that daylights along the western property line is a mix of low-lying vegetation. A review by the landscape architect and the commission will evaluate any invasives that are to be removed as part of the project.***

(6) amount of impervious surface

- ***The existing AURA for the western part of the site has 85 sf of impervious area, from a small shed structure. In the proposed condition, the impervious coverage is removed.***

(7) wildlife and wildlife habitat

- ***The AURA under existing and proposed conditions will change little due to the minimal changes to the form and function of the area, however the proposed additional plantings will improve habitat.***

(8) intensity and extent of use

- ***The use within the AURA will not change as it will remain for athletics. The turf program will provide more usable months than the natural grass fields for a slight increase in intensity but not in any way that would change its effect on the AURA.***

(9) intensity and extent of adjacent and nearby uses

- ***The use of adjacent areas to the AURA will not change as it will remain for athletics. The turf program will provide more usable months than the natural grass fields for a slight increase in intensity but not in any way that would change its effect on the adjacent uses.***

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(10) capacity to provide resiliency to climate change

- The turf field will adequately hold and convey stormwater and can handle storm events that would make the natural turf field unusable.

Alternative analysis:

Alternative 1: Renovation Only
An alternative to the selected option is to renovate the existing School, along with additions to the existing school. These alternatives also leave the existing shed and invasives.
Alternative 2: Grass Fields
The Arlington High School Building Committee has held public meetings for over three years and many discussions centered on the benefits of installing an artificial turf field (similar to the one currently at the high school stadium) for all other sports. As designed the new artificial turf fields will serve baseball, softball, soccer, lacrosse, and football. This is due to the ability to layout out overlapping sports within the same footprint. Many discussions regarding costs/benefits analysis occurred when the Committee needed to reduce project costs. It was agreed by the 18-person committee that artificial turf fields versus natural grass turf fields are essential for the high school program. The artificial turf, with its superior drainage, will allow for six (6) more weeks of outdoor activity for Arlington students. This benefit was paramount to the educators, parents, and residents of the School Building Committee.

These additional six weeks of outdoor activity also assumes that the grassed fields remain in playable condition for the entire fall and spring season. In actuality, the grassed fields typically become muddied and bare – causing erosion and siltation – most season due to challenging weather and over-use for that surface versus student activity needs. The selection of turf fields will remove that siltation source to the resource areas.

Alternative 3: No Build
The proposed School would not be built in this scenario. This does not meet the program requirements for the school / district and the AURA would be kept in its current condition which does not provide water quality within the stormwater system, doesn't provide trees to shade the wetlands and currently has a parking lot in need of repair.

D. No activities or work, other than passive passage and resource area enhancement, are permitted within the first 25 feet of the Adjacent Upland Resource Area (measured horizontally from a resource area specified in Section 2, A(1) through (4). Except as part of Resource Area Enhancement or an Ecological Restoration Project, no vegetation may be disturbed, and leaf litter and natural debris shall remain in place. This No-Disturbance area shall at a minimum contain the same amount of area of undisturbed and natural vegetation from its pre-project state. A previously disturbed or previously developed 25-foot area shall be restored to a naturally vegetated state to the greatest extent practicable.

Under proposed conditions the impervious area within 25' of the wetland resource area has been reduced.

E. No new structure(s) shall be placed in the first 50 feet of the Adjacent Upland Resource Area (measured horizontally from a resource area specified in Section 2, A(1) through (4)), unless approved by the Commission in evaluation of existing total impervious surface (see Section F. below) within the 50-foot area compared to the proposed impervious surface, and other considerations for the improvement of the resource area and climate change resiliency.

Under proposed conditions the impervious area within 50' of the wetland resource area has remained the same. The new stormwater BMP's and landscaping will aid in the climate resiliency.

F. Impervious surface.
(1) The total area of impervious surface within the Adjacent Upland Resource Area shall not increase over existing total area unless mitigation is provided and there is no impact on Resource Area values.

The existing impervious within the 25’ and 50’ buffer is slightly reduced.

(2) Impervious surfaces shall not intrude farther into the Adjacent Upland Resource Area than pre-project conditions unless the Commission in its sole discretion determines that the total area of impervious surface is significantly decreased or other mitigation is provided that serves to protect the resource area values. Impervious surface shall be kept as close as possible to the outer (upland) boundary of the Adjacent Upland Resource Area.

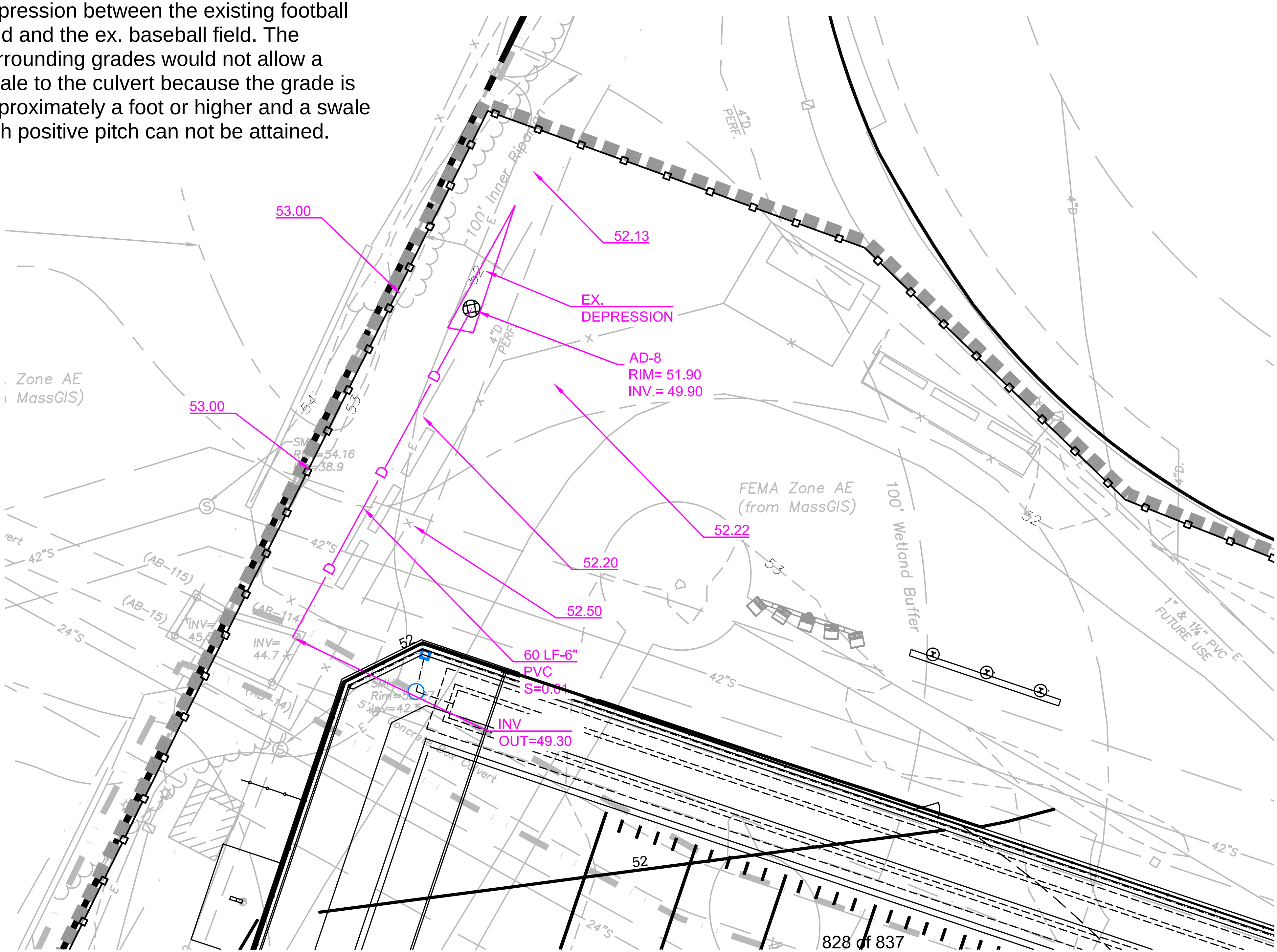
The proposed impervious area is slightly reduced.

G. The following activities may not be conducted in any portion of the Adjacent Upland Resource Area: changing of oil, refueling, or damage to other vegetation not scheduled for removal.

None of the uses listed above are to be performed under the proposed design and all re-fueling of construction vehicles will take place outside the AURA in designated areas.

P:\Projects\2017\17211.00 Arlington HS, 869 Mass Ave (Civil)\Documents\Item#1 AURA Analysis.doc

The area drain serves to drain a natural depression between the existing football field and the ex. baseball field. The surrounding grades would not allow a swale to the culvert because the grade is approximately a foot or higher and a swale with positive pitch can not be attained.



From: "Trevor (A Yard & A Half)" <trevor@ayardandahalf.com>
To: Emily Sullivan <ESullivan@town.arlington.ma.us>
Date: 07/10/2020 05:47 AM
Subject: Fall

HI Emily
Thank again for shepherding the Howard project and it looks like I'llbe seeing you again on the Cooney property.
A few points on what I heard last night.
I think the committee needs to address plow patterns. If the parking lot is plowed directly into the bioretention cell it will surely fail, unless there is a "plow zone" designed into it to infiltrate the pile. In that same line the bioretention media should be designed to handle the specific runoff from a parking lot including the salt. Adding gypsum to the mix will help with that as well as a soil drench as part of maintenance.
Lastly and I admit i am not familiar with the project, budget or what has been discussed, but there are plenty of rain harvesting products out there that may fit the budget and even more storage systems to increase the capacity of the bioretention cell and even allow the sloped strip they spoke of to become an additional bioretention cell.
I realize I am late to the table and wish I had not been. This is a wonderful opportunity for Arlington to shine in the area of stormwater management in a new construction and just like the center I think it will be an opportunity missed.
Thank you again for all your help and I look forward to working with you again soon.
Trevor
--

Trevor Smith
He, Him, His
Project Manager
A Yard & A Half Landscaping Cooperative, Inc.

From: kristina keefe-perry <stina.perry@gmail.com>
To: esullivan@town.arlington.ma.us
Date: 07/13/2020 09:57 AM
Subject: Concerns with Artificial Turf at AHS

Dear Emily,

My apologies for this late comment. There was some confusion about the date of this hearing. I am writing to voice my concern with and opposition to artificial pitch surfaces at the new High School.

Most artificial turf is made with old tires (aka: crumb rubber). Crumb rubber from tires may contain various metals such as cadmium, chromium, zinc, aluminium and lead; oils containing various chemicals including volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs) such as benzo (a and e) pyrenes, benzo (a) anthracene as well as phthalates. Several of these are known or suspect carcinogens, neurotoxins and potential endocrine disruptors. The crumbs have been implicated in causing cancer in adolescents and young adults who use the fields, particularly lymphoma and primarily in soccer goalkeepers. This concern has led to the initiation of large-scale studies by local and federal governments that are expected to take years to complete.

In addition, artificial turf means lost habitat for insects - particularly important pollinators. The runoff may contaminate nearby waterways. Finally, artificial turf contributes to more injuries - particularly concussions.

As the mother of a tween - who will be at the high school in three years, and inheriting the environment we steward (or don't) - I want to voice my strong opposition to synthetic pitch at the High School.

Thank you for your time and passing this along.

Kristina Perry

Hi Susan,
I didn't see the link for comments about the proposed artificial turf fields, so here is mine:

I'm a parent facilitator of the Thompson Green Team and a parent of 2 select team soccer players, so I'm well versed with the concerns on both sides of the proposed soccer fields.

My son's 7th grade peers are passionate about soccer and have been playing soccer regularly on the natural field next to Thompson since first grade. Although formal practices and games have occasionally been delayed by lack of access to turf fields in Arlington, their passion for soccer has persisted.

In addition to soccer, this peer group of Thompson graduates have been equally passionate about protecting the environment, banning all forms of single use plastic, protecting pollinator ecosystems and addressing climate change! They have lobbied the APS Director of Food Services, APS School Committee and their school communities to eliminate Styrofoam trays, plastic straws and plastic cups and for a switch to compostable trays and industrial composting for school lunches throughout the district. They organized all town climate rallies, wrote letters and lobbied their State Senator and Representative to pass bold, comprehensive climate legislation. The Thompson community also planted pollinator gardens around the school and in their neighborhoods.

Replacing the natural soccer fields with artificial turf fields is not consistent with the hopes and dreams of this generation.

Given the challenges of maintaining a livable climate and pollinator ecosystems for the next generation, we need to plan ahead and take responsibility by cultivating green space and native pollinator ecosystems at every opportunity. Our children are resilient and will persist in learning soccer despite the occasional rainy day (or pandemic!). Our ecosystems and climate are dangerously close to tipping points of irreparable damage and at some point will be less resilient. The elimination of green space and the production of plastics add up and heighten levels of carbon dioxide in the atmosphere worsening climate change.

Instead of reducing green space, I'd like to see any new town plans mandate increased green space and native pollinator ecosystems that both decrease the levels of carbon dioxide of the atmosphere reducing the threat of climate change and support easy to maintain native ecosystems for our all important pollinators protecting our food supply.

I hope the town of Arlington will consider this generation's hopes and dreams for a sustainable town and livable climate!

Thank you,

Elizabeth Rocco M.D.
Thompson Green Team
Mom of Grade 4 and 7 Select Team Soccer Player

From: Madeline Brambilla <mbcc.madeline@gmail.com>
To: esullivan@town.arlington.ma.us
Date: 07/13/2020 11:02 AM
Subject: Comment for for artificial turf at AHS

Dear Emily,

Please accept my comment below for the continued hearing on 7/16 for the NOI for artificial turf at AHS.

Most artificial turf is made with old tires. Artificial turfs like these may contain various metals such as cadmium, chromium, zinc, aluminium and lead; oils containing various chemicals including volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs) such as benzo (a and e) pyrenes, benzo (a) anthracene as well as phthalates. Several of these are known or suspect carcinogens, neurotoxins and potential endocrine disruptors.

These synthetic fields have been implicated in causing cancer in adolescents and young adults who use them, particularly lymphoma and primarily in soccer goalkeepers. This concern has led to the initiation of large-scale studies by local and federal governments that are expected to take years to complete.

In addition, artificial turf means lost habitat for insects - particularly important pollinators. The runoff may contaminate nearby waterways. Finally, artificial turf contributes to more injuries - particularly concussions.

As a parent of children attending Arlington public schools, I want to voice my strong opposition to synthetic pitch at the High School.

Sincerely,

Madeline Brambilla

From: Wyatt LaCoss <wlacoss@gmail.com>
To: esullivan@town.arlington.ma.us
Date: 07/13/2020 03:56 PM
Subject: Artificial Turf...

Dear Ms. Sullivan,

Please accept my comment below for the continued hearing on 7/16 for the NOI for artificial turf at AHS.

I want to voice my strong opposition to synthetic pitch at the High School.

Most artificial turf is made with old tires. Artificial turfs like these may contain various metals such as cadmium, chromium, zinc, aluminium and lead; oils containing various chemicals including volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs) such as benzo (a and e) pyrenes, benzo (a) anthracene as well as phthalates. Several of these are known or suspect carcinogens, neurotoxins and potential endocrine disruptors.

These synthetic fields have been implicated in causing cancer in adolescents and young adults who use them, particularly lymphoma and primarily in soccer goalkeepers. This concern has led to the initiation of large-scale studies by local and federal governments that are expected to take years to complete.

In addition, artificial turf means lost habitat for insects - particularly important pollinators. The runoff may contaminate nearby waterways. Finally, artificial turf contributes to more injuries - particularly concussions.

Sincerely,
Wyatt LaCoss

Arlington Resident

From: Jessi Smolow <jessi.smolow@gmail.com>
To: esullivan@town.arlington.ma.us
Date: 07/13/2020 10:16 PM
Subject: Please, no artificial turf!

Dear Emily,

Please accept my comment below for the continued hearing on 7/16 for the NOI for artificial turf at AHS.
I want to voice my strong opposition to synthetic pitch at the High School.
Most artificial turf is made with old tires. Artificial turfs like these may contain various metals such as cadmium, chromium, zinc, aluminium and lead; oils containing various chemicals including volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs) such as benzo (a and e) pyrenes, benzo (a) anthracene as well as phthalates. Several of these are known or suspect carcinogens, neurotoxins and potential endocrine disruptors.
These synthetic fields have been implicated in causing cancer in adolescents and young adults who use them, particularly lymphoma and primarily in soccer goalkeepers. This concern has led to the initiation of large-scale studies by local and federal governments that are expected to take years to complete.
In addition, artificial turf means lost habitat for insects - particularly important pollinators. The runoff may contaminate nearby waterways. Finally, artificial turf contributes to more injuries - particularly concussions.

Sincerely,
Jessica Smolow

From: James Fleming <jflemingwpl13@gmail.com>
To: esullivan@town.arlington.ma.us
Date: 07/13/2020 08:54 PM
Subject: Artificial turf installation at AHS

Hi Emily!

Please accept my comment below for the continued hearing on 7/16 for the NOI for artificial turf at AHS.

I am opposed based on evidence that artificial turf is a more expensive long-term solution and is less safe than natural grass turf. I urge you to investigate the costs and safety of an artificial turf in greater depth than I can.

An article in Forbes (which cites other sources) covered incidents where the cost of artificial turf was found to be higher than that of natural grass turf. For Montgomery County, the 20-year cost of an artificial turf installation was approximately $931,000 greater than a grass field installation (2.61M vs 1.68M).

Forbes article - https://www.forbes.com/sites/mikeozanian/2014/09/28/how-taxpayers-get-fooled-on-the-cost-of-an-artificial-turf-field

A report from WISH in Indiana found evidence that artificial turf was less safe than natural grass, because of its propensity to cause burns on skin:

"The surface temperature on the artificial turf is almost twice the temperature of the natural grass. It was a full 65 degrees hotter than in the shade and nearly 55 degrees hotter than in the sun.

If you think the black asphalt where the band practices must be even hotter, think again. Asphalt is actually a cooler surface.
...

We talked to one another area coach who usually plays on natural grass. He told I-Team 8 he did a three day camp on artificial turf and had blisters on his feet because of the heat."

WISH in Greenwood, Ind -
https://web.archive.org/web/20110602183041/http://www.wishtv.com/dpp/news/Turf_Temperatures_20090730

From: Josh Schreiber Shalem <feldyviol@gmail.com>
To: esullivan@town.arlington.ma.us
Cc: s.chapnick@comcast.net
Date: 07/14/2020 03:24 PM
Subject: Comment in opposition to synthetic turf at AHS

CAUTION: This email originated from outside of the Town of Arlington's email system. Do not click links or open attachments unless you recognize the REAL sender (whose email address in the From: line in "< >" brackets) and you know the content is safe.

Dear Emily,

Please accept my comment below for the continued hearing on 7/16 for the NOI for artificial turf at AHS.

As a parent of a child attending Arlington public schools, I want to voice my strong opposition to synthetic pitch at the High School.

I oppose synthetic pitch on the grounds that I believe it is 1) bad for our children, and 2) bad for the environment.

1) Bad for our children:

Most artificial turf is made with old tires. Artificial turfs like these may contain various metals such as cadmium, chromium, zinc, aluminium and lead; oils containing various chemicals including volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs) such as benzo (a and e) pyrenes, benzo (a) anthracene as well as phthalates. Several of these are known or suspect carcinogens, neurotoxins and potential endocrine disruptors.

These synthetic fields have been implicated in causing cancer in adolescents and young adults who use them, particularly lymphoma and primarily in soccer goalkeepers. This concern has led to the initiation of large-scale studies by local and federal governments that are expected to take years to complete. Our children should not be part of such a risk experiment.

Finally, artificial turf contributes to more injuries - particularly concussions.

2) bad for the environment

Artificial turf means lost habitat for insects - particularly important pollinators.

The runoff may contaminate nearby waterways (the Mill brook).

Finally, artificial turf contributes to climate change. It gets hotter than natural turf, and does not capture carbon the way natural turf does. **I feel it is important that we do whatever we can in our public projects to mitigate the effects of climate change.** Replacing grass with artificial turf does the opposite.

Sincerely,

Joshua Shalem

From: Home Email <halfpennypardo@yahoo.com>
To: esullivan@town.arlington.ma.us
Date: 07/14/2020 10:18 PM
Subject: Artificial turf

Hi Emily,
I'm an Arlington resident with 2 kids in the school system. I'm also a green team parent at Stratton.
We have worked very hard to build pollinator gardens in our homes and at school and we have learned so much about the local eco system here in Arlington. I'm discouraged and I disagree with the proposal for artificial turf fields due the negative environmental factors and impacts of the turf. We are aware of the chemicals within the turf that may leak over time and I'm concerned additional lost habitat. It seems like a big compromise for a better looking field. Please reconsider and stick with the natural elements.
Thank you,
Tina Halfpenny